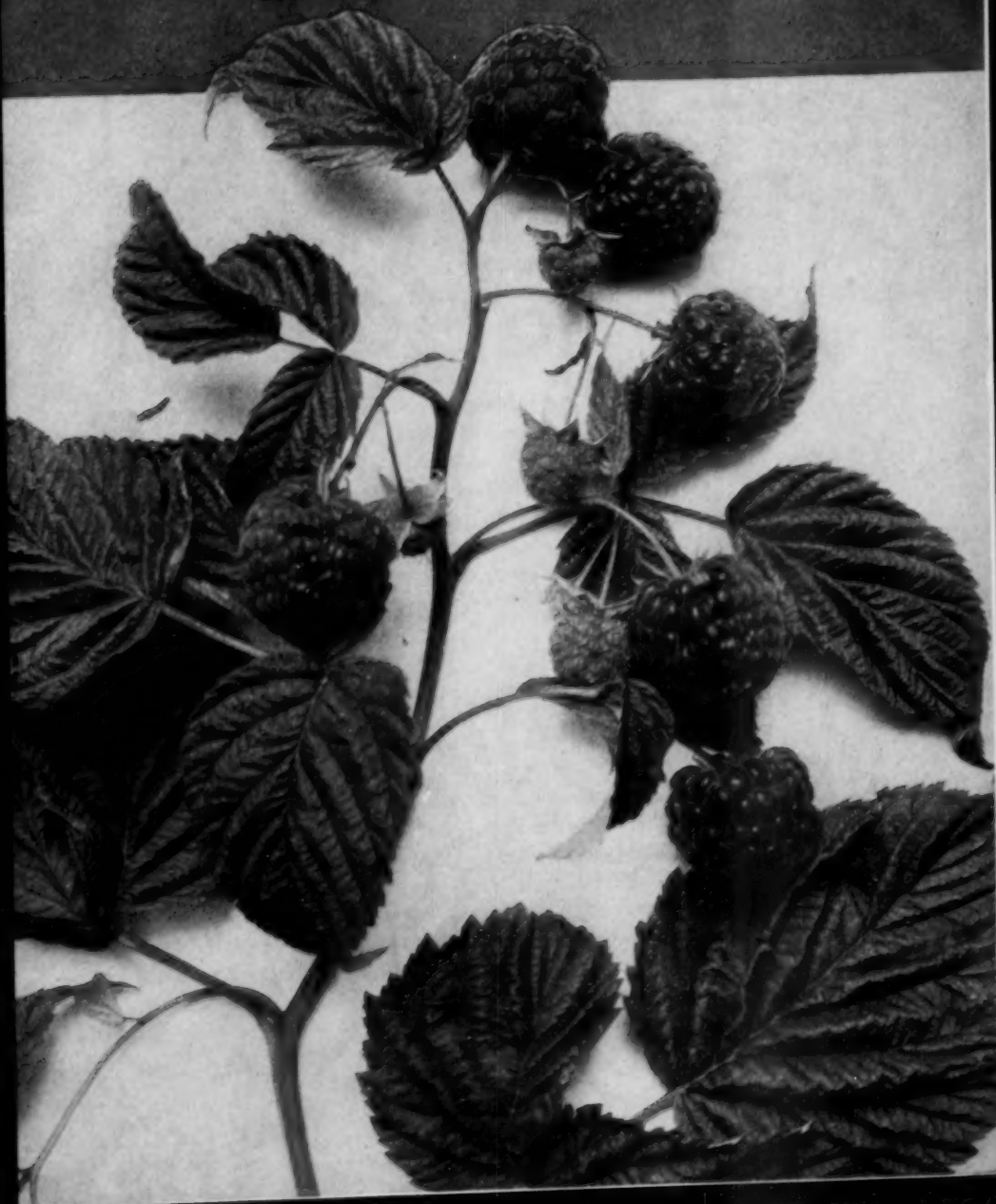


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Raspberry Growing

CULTURE, DISEASES and INSECTS



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RASPBERRY GROWING

CULTURE, DISEASES, AND INSECTS

By G. L. SLATE, A. J. BRAUN, AND F. G. MUNDINGER

SELECTION OF SITE

Soil

A suitable soil is of the utmost importance. The ideal soil is a fine deep sandy loam, well supplied with humus and retentive of moisture, but well drained; however, raspberries may do well on lighter or heavier soils. Good crops may be obtained on well-drained clays, but this type is hard to work and bakes quickly. Where crown-gall is a menace, the heavier type may be preferable. Fruiting and cane growth come at a time when soil moisture is low, consequently the soil that is retentive of moisture is to be preferred. Some varieties have a decided preference for certain soil types. June prefers a clay soil, Cuthbert likes a lighter soil, and Latham is more cosmopolitan in its requirements. The soil reaction is not important, although raspberries are usually thought to prefer a slightly acid soil.

If the grower is contemplating the production of plants, especially the tip-rooting varieties, a light soil is absolutely essential. The tips root with difficulty in clay, the plants are small, and the root systems weak. It is often impossible to dig plants in the spring until growth is so far advanced as to result in considerable injury to the plants. Digging is slow and expensive and the plants are far inferior to those grown on the lighter soil.

Drainage

Good drainage contributes much to the success and long life of the plantation. The root system of a raspberry plant in a good soil extends to a depth of 3 feet, with the bulk of the roots in the upper 2 feet of soil. Consequently, the water level should not come nearer the surface than 3 feet for more than a few days. A gentle slope is advisable for surface drainage during heavy rainfall or rapidly melting snow.

Poor drainage is the cause for much winter injury; the wet soil stimulates late autumn growth which fails to ripen properly. A soil that is saturated a few weeks during the growing season may cause the death of the plants at that time.

Humus

An abundance of humus is valuable in improving the moisture-holding capacity and fertility of the soil. A heavy soil well supplied with humus works more easily and bakes less than one deficient in that constituent. Soils deficient in humus should be built up in organic matter before the plants are set. An application of 20 tons or more of manure to the acre will add considerable humus, or a heavy growth of some green-manure crop may be plowed under. This is preferably done a year in advance of planting the berries.

Air drainage

Air drainage is usually of less importance than the other requirements, but it should be considered. "Pockets" or low spots surrounded by higher ground or any configuration of the land or trees that tends to dam up the downward flow of cold air are colder in winter and more subject to frosts. Plants in such spots are more subject to certain diseases that depend on moisture on the foliage or cane for their incidence. Mildew on Latham is much more serious where air drainage is poor. Heavy infections by the fungi causing anthracnose and spur-blight are also favored by poor air drainage.

Exposure

The exposure of a piece of ground influences directly the season of ripening of a variety; a southern exposure is earlier than a northern one. Hence the season of a variety may be accentuated by planting early varieties on a southern slope and late varieties on a northern slope. A north slope is usually cooler and the soil dries out less rapidly. Southern slopes may be conducive to winter-killing of canes, through warming up the buds and inducing breaking of dormancy prematurely in the spring.

Protection from wind prevents breakage of canes and loss of fruit from whipping. A protected field is more comfortable for pruning in cold weather, and pickers are less annoyed by the movement of the canes. On the protected field snow drifts less and remains longer. There is less evaporation from the soil and the canes, and consequently less winter injury.

Weeds

The fewer weeds on the intended site, the easier it will be to care for the planting. Any serious weeds, such as quackgrass, should be eliminated before the plants are set. It is practically impossible to

clean out quackgrass in an established berry field, and it is usually cheaper to set a new planting than attempt to clean up one infested with grass.

Usually it is inadvisable to plant raspberries immediately after raspberries or immediately adjoining an old neglected planting, for the new planting may inherit some of the insects and diseases of the old planting.

PREPARATION OF SOIL, AND PLANTING

Thorough preparation of the soil is of prime importance in getting a good stand of plants and enough cane growth for a light crop the second year. Whenever possible it is desirable to start preparing the field for berries two or three years in advance. Weeds should be eliminated, humus provided either by stable manure or green manure crops, and a hoed crop should be grown one year before the raspberries are set.

Deep plowing, from 6 to 8 inches, followed by thorough disking and harrowing will fit the ground satisfactorily. The soil must be well pulverized and mellow.

Although spring setting is generally advised by various authorities, fall planting has been successful with the red varieties at the Geneva Station. Fall planting permits the work to be done at a comparatively slack time, lessens the danger of the roots drying out as the weather is cooler, and generally provides more time to fit the ground properly. Plants purchased from nurseries in the fall are fresh out of the ground, whereas plants purchased in the spring may have been stored throughout the winter under not too favorable conditions. Fall-set plants become thoroughly established during the winter and are off to a good start in the spring. To prevent heaving out of the newly set plants during the winter, it is advisable to plow a furrow up to the row of plants or to mulch them with a strawy manure. This furrow should be worked down in the spring.

Spring planting should take place as early as the ground can be fitted, since the early set plants become established before the weather is hot and dry. Growth of new shoots from the base of the cane starts early and there is danger of breakage if they are not set early. Late spring setting often results in poor stands if weather conditions are unfavorable.

The black and purple raspberries are always set in the spring. Some growers wait until the tip plants are well started before moving

them to the new planting. This practice is unwise. A young tip plant even before growth starts is fully equipped with a good root system and buds from which the new canes will develop, and it needs no more help from the mother plant. The chief harm done by delaying the removal of the tips is to the parent plant which may not be pruned until the foliage is well advanced. Cultivation is also delayed, weeds become established, and the plants receive a decided setback. Also, the anthracnose fungus often becomes established on the new plants, and causes injury the first year.

The plants are set at about the same depth or slightly deeper than they grew previously. The tops of the red raspberries are cut back to a height of 6 inches before setting; this length of cane is left to mark the row and facilitate handling. If too long a cane is left, the plant may die before becoming established. No fruit should be expected the first season. The cane or "handle" on the black and purple varieties should be removed entirely if anthracnose is present.

The operation of setting is commonly done in one of two ways. The row is furrowed with a plow, the plants are set against the straight side of the furrow, partially covered, and later the furrow is filled with the plow. With the other method, two men constitute a planting team; one opens the ground with a spade, the other thrusts the plant into the hole, after which the spade is again inserted in the ground and the soil pressed against the plant. Care should be taken with both methods to firm the soil so tightly against the roots that the set plant will resist a strong tug without loosening. Care should be taken not to set the plants too deep or the growing points may not be able to break through; if set too shallow, the plants may dry out. In light soils red raspberries may be set as much as 3 inches deeper than they grew, but tip plants only an inch or two deeper.

During the operation of setting, the plants should not be permitted to dry out at any time. They may be wrapped in wet burlap or kept in tubs of muddy water. Only as many plants as can be set before the roots dry off are dropped ahead of the planting crew.

The distances for setting the plants are determined by the system of culture that is to be followed. In the hill system, red raspberries are usually set about 5 feet apart each way. The black and purple varieties require 5 or 6 feet each way if grown in hills. In the hedge-row system the rows are 7 or 8 feet apart; the red varieties are set 2 or 3 feet apart in the row and the black varieties from 2½ to 3½ feet. If a tractor is to be used for cultivation, the rows will need to be 8 or 9 feet apart.

PROPAGATION AND PLANTING STOCK

Red raspberries are propagated by the suckers that spring from the roots. These sucker plants may be set directly in the field or they may be grown a year in the nursery row after which they are known as *transplants*. The higher cost of large-size sucker plants or transplants that have grown a year in the nursery row is not warranted as the smaller sizes will give as good a stand of plants. For home use the transplant may be desirable since it need not be cut back so severely as the sucker plant and consequently may produce some fruit the first season.

The grower who raises his own red raspberry plants will find it inadvisable to dig suckers freely throughout the field as considerable injury to the old plants may result. It is better to set aside a portion of the field for propagation purposes and dig all the plants. Enough pieces of roots will be left in the ground to grow another crop of plants. If this is done continuously, the ground must be kept very fertile with manure and fertilizer; otherwise the field will soon run out. Plants should not be dug until the grower is ready to set them. Plants that must be dug much in advance of setting may be heeled-in in a shady moist spot, preferably the north side of a building. If the soil is well packed around the roots, the plants will remain in good condition until needed.

Another method of propagating the red varieties that is popular with some growers is to set young green sucker plants early in June, or as soon as they are a few inches in height. The sucker is dug carefully as soon as the new roots are well started, care being taken to get a piece of the old root. Unless the weather is moist and cloudy and rain comes soon, many plants are usually lost. The production of an abundance of sucker plants may be stimulated by striking a spade into the ground around the old plants or by deep cultivation to break off the roots, each piece of which will send up a new sucker. This method is of value for the rapid increase of stock of new varieties. It also aids in the selection of healthy, disease-free plants as mosaic symptoms are expressed clearly on the foliage of the suckers.

The black and purple varieties are propagated by tip layering, commonly known as *tipping*. Late in the summer, usually about the end of August, the ends of the canes droop to the ground, the tips become somewhat snakelike in appearance with small curved leaves, and develop roots if in contact with moist, mellow soil. As only a small proportion of the tips root naturally, they are buried by the grower to make certain that they will remain in one place and de-

velop roots. This is usually done by opening a hole in the soil with a spade or trowel, inserting a tip vertically to a depth of 3 inches, and pressing the soil against it. By fall the tip will have developed a good root system. The following spring it is dug and severed from the mother plant. This young plant may be grown a year in the nursery, then set or sold as a transplant. For most conditions though, the tip plant is satisfactory, and the additional cost of transplants is not warranted.

Tip plants are delicate and easily injured. At no time should they be permitted to dry out. They do not ship well and whenever possible the grower should raise his own plants or purchase them from nearby plantings. Tips grown on sandy or mellow loamy soils are far superior to those grown on clay. On a clay soil many roots are destroyed and the cost of digging is prohibitive.

SYSTEMS OF PLANTING

Hill system

Red raspberries may be grown according to several systems. When grown according to the hill system, which is popular in the Hudson Valley, the plants are set 5 by 5 feet and may or may not be staked. The hill system has the advantage of permitting cross cultivation, thus eliminating considerable hoeing, and of making harvesting somewhat easier. The disadvantages of this system are the lower yield resulting from the small number of canes to the acre, a more rapid rate of spread of mosaic, and the leaving of a much larger hole in the field when the diseased plants are removed than would be left by removing the same number from the hedge row.

Hedge row

The wide hedge row which is often 2 or 3 feet wide has several marked disadvantages and is not to be recommended. The fruiting laterals in the center of the row are crowded and may die, berries are overlooked by the pickers, and are either lost or picked later when over-ripe, weak canes are produced which bend over and allow the berries to get dirty, and fungous diseases dependent upon moisture for their incidence may be more severe on the shaded canes of a wide row.

The narrow hedge row is perhaps the most suitable system for New York. In this system the rows are 7 or 8 feet apart, or more if a tractor is to be used for cultivation. The row is restricted by cultiva-

tion and pruning to a width of 1 foot. Because of the large number of canes to the acre, greater yields are possible than with the hill system and, because of the narrowness of the row, the faults of the wide hedge row are eliminated.

Linear system

In the linear system, which is popular on the Pacific Coast, only the original plants are kept for fruiting and all suckers are removed. A minimum of hand-work is necessary with this system.

The black and purple raspberries are usually grown by the linear system with the plants set from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet apart in rows from 7 to 9 feet apart. If grown in hills, they are spaced 5 or 6 feet apart each way.

In the past, raspberry plants have been supported extensively, especially in the Hudson Valley. Many growers are abandoning the use of supports and with many varieties they are not essential. Supports are expensive and one can afford to lose many berries before resorting to them. Sometimes severe pruning may obviate the necessity for support. The advent of the Newburgh raspberry with its low habit of growth, long fruiting laterals, and very heavy crop may revive the use of supports, and for that reason a simple trellis is described.

A series of posts are set in each row at intervals of 15 to 30 feet. The height of the post depends on the height of the canes, but will usually be from 3 to 4 feet above the ground. Near the top of each post is nailed a cross piece about 18 inches long. A wire is run along each side of the row and attached to the ends of the cross pieces. The canes are allowed to hang over the wires or may be tied to them.

Another method is to run a single wire down the center of the row and attached to posts at a height varying from 3 to 5 feet, depending on the length of the canes. The canes are tied to this wire.

Several other methods of supporting raspberry canes are described and illustrated in United States Department of Agriculture Farmers' Bulletin 887, which may be obtained on request from the Government Printing Office at Washington.

CARE OF PLANTATION

Every effort must be made to conserve moisture. The growth of the canes and the ripening of the berries take place in midsummer when the supply of moisture is often deficient. Moisture, more than any other condition, influences berry size, and consequently heavy

yields. Thorough cultivation is one of the most effective ways to conserve moisture. Cultivation begins soon after planting and in an established planting as soon as the ground can be worked in the spring. It should be shallow at all times and should be enough to keep down weeds and to prevent a crust from forming.

Raspberries are shallow rooted and easily injured. Cultivating 4 inches is deep enough, and it is advisable to shorten the cultivator teeth next to the plants. Any quackgrass that appears in the new planting must be subdued at once, as it is impossible to eradicate after the rows are filled with canes. Suckers are not allowed to grow between the rows. An occasional hand hoeing is necessary to clean out weeds between the plants. If grass becomes established between the canes, it is usually cheaper to take out the planting and set another than to attempt to clean out the grass.

Cultivation should not be continued much beyond the picking season as the growth stimulated by late cultivation will not mature enough to withstand the winter. Every effort should be made to stimulate rapid and vigorous growth of the canes early in the season, so late growth will not be necessary to provide fruiting wood for the following season. During the picking season it may be necessary to suspend cultivation to prevent knocking off berries or the breakage of canes that may have bent over from the weight of the fruit. If the canes are trellised, cultivation may continue throughout the picking season unless the soil is too dusty.

After the picking season, the ground may be prepared and a cover crop sown. Cover crops are rarely used in raspberry plantings in this State, but they are useful and deserve the attention of every grower of raspberries. Not only do they add considerable humus to the soil but, what is more important, they aid very materially in ripening the canes by competing with them for food and moisture during the fall, thus preventing rank growth and consequent winter injury. In some experiments in Missouri the effectiveness of the cover crop was increased by fertilizing with a nitrogenous fertilizer. The increased growth of the cover crop as a result of fertilization used up more soil moisture and permitted better ripening of the canes. The cover crop is more valuable in a wet fall than in a dry one.

Suitable cover crops are barley, oats, buckwheat, and golden millet. These have the advantage of not living over winter. Crops which live over winter should be drilled so they will not become established between the plants as weeds the following season. The cover crop may be turned under early in the spring or, if the land is not subject to washing, this may be done in late fall after growth has ceased.

In late fall it is customary, especially on heavy soils, to plow a shallow furrow towards the plants for winter protection of the crowns. If there is danger of water lying on the ground during the winter, this furrow will carry off the surplus. In the spring the ground may be levelled with a cultivator. A grape hoe is useful to work the soil towards and away from berry rows.

In the spring on the heavier soils it may be necessary to plow or disk the space between the rows before starting cultivation. This should be shallow, not more than 4 inches in the center or 2 or 3 inches next to the plants. After this plowing, the land may be worked as usual with the cultivator.

A suitable mulching material, such as hay, straw, leaves, or similar substances, may be used to good advantage instead of cultivation but the mulch must be free from weeds. It is applied between the rows to a depth of from 4 to 6 inches. The first two years the mulch is on the field it may be necessary to fertilize liberally with a nitrogenous fertilizer to compensate for the nitrogen required by the organisms that are rotting the mulch. Eventually the mulch itself, as it becomes incorporated in the soil, will supply considerable nitrogen.

During the first season the unoccupied space between the rows may be utilized by an intercrop, such as beans, peas, summer squash, cabbage, or cauliflower. Tomatoes and early potatoes should not be interplanted with raspberries owing to the susceptibility of the raspberries to the wilt disease which may be brought to the field by the tomatoes and potatoes. Crops should not be grown near enough to the berry plants to compete with them for moisture and food. After the first season no other crop should be grown, as the berry roots fully occupy the ground.

FERTILIZING

There is little definite information as to what fertilizers are profitable on brambles. On reasonably fertile soils well supplied with humus, fertilizers may not be needed.

Phosphoric acid and potash have not been shown to be profitable in fertilizer experiments with raspberries, and their use is not recommended. When cover crops are used, it may be necessary to apply from 300 to 400 pounds of superphosphate per acre for the cover crop, and with a non-leguminous cover crop some nitrogen may be needed. This must be determined by the grower himself by observing the growth of the cover crop.

Since there is a general correlation between the vigor and productivity of a plant, it seems desirable to stimulate the development of strong vigorous canes. Before using fertilizers the grower must therefore determine whether he is satisfied with the present growth and vigor of his plants. If it seems desirable to stimulate additional growth, the use of nitrate of soda or sulfate of ammonia at the rate of from 250 to 300 pounds an acre is suggested. Excessive amounts of nitrogen should be used with caution since an overdose of this element tends to make the berries soft and difficult to handle. It must be applied between the rows and not directly on the crowns of the plants. Because of the danger of stimulating late autumn growth, it is suggested that the fertilizer be applied early in the spring just or slightly before growth starts.

When it is available, stable manure applied annually at the rate of 10 tons to the acre is always helpful. In addition to furnishing plant food, stable manure aids materially in building up the humus supply and moisture-holding capacity of the soil, as well as improving its physical condition. Hen manure is frequently used on raspberries with good results. It is valuable chiefly for its nitrogen which varies in amount from 0.5 to 1.5 per cent and averages about 1.0 per cent. Enough should be applied to furnish about 50 pounds of nitrogen to the acre.

PRUNING

RED RASPBERRIES

The canes of red raspberries are biennial; that is, they complete their growth in height the first season, bear fruit the second, and then die. The roots are perennial, living for many years, sending up a new crop of canes each year. The canes are of two types, those that develop from buds at the base of the old canes, and those that develop from the roots at a distance from the crown. Those that develop from the roots are known as *suckers*, and red raspberry varieties vary considerably in the number of suckers they produce. Certain varieties, such as June and Marlboro, sucker rather sparingly, whereas others, such as Cuthbert and Newburgh, produce suckers in great abundance. Unless these suckers are periodically reduced in number, the planting soon becomes a dense thicket of little value for fruit production. The fruit buds are formed in the fall on the current season's growth. The following spring they develop into branches and bear fruit.

As soon as the crop is harvested it is customary to remove the

fruiting canes. This gives more room for the new growth and destroys many insects in the old canes. Where deep snow breaks the new canes during the winter, the old canes may be left until spring for support. A V-shaped brush hook or long-handled pruning shears are suitable for this pruning.

In the spring after the severe winter weather is past and there is no more danger of winter injury, the fruiting canes are pruned. This pruning consists in cutting back the fruiting cane to a height of from 4 to 5 feet, depending on the vigor of the variety. The cutting back should be as light as will permit the cane to remain erect with its load of fruit. In general, the removal of the relatively weak growth at the tip, which is indicated by the short internodes, will be enough. Branches may be cut back to about 10 inches or 15 buds. Some growers of early varieties who stake or trellis their canes leave this tip growth for the sake of the earlier berries. Even though these tip berries are rather small, they bring a high price because of their earliness. Failure to remove the tip growth will not materially reduce the size of the berries on the remainder of the cane. On light soils subject to drought it may be advisable to cut back the canes more severely than on soils abundantly supplied with moisture.

Severe heading back of the canes at spring pruning has several marked disadvantages. The crop is materially reduced, but the size of the berries is not correspondingly increased. If the height of the fruiting canes is severely reduced, the fruiting laterals that develop on the remainder of the cane will be hidden among the new shoots of the current season, thus making harvesting more difficult. The fruit on the laterals of the severely pruned canes will ripen considerably later than that on the moderately pruned canes. Only a few fruiting laterals will develop from the basal buds of red raspberries since many of these lower buds are blind. At this spring pruning the weak canes should be removed and the remainder thinned to about 6 inches apart.

During the growing season the new shoots should not be headed. Heading them results in the production of weak side shoots and tends to increase the number of suckers, an undesirable condition in a planting devoted exclusively to fruit production. The weak branches are more susceptible to winter injury than the normal unheaded canes.

BLACK AND PURPLE RASPBERRIES

During the summer it is necessary to check the terminal growth of the new shoots of the black and purple raspberries by pinching

off the tips. If allowed to grow naturally, they make long sprawling canes difficult to manage. To prevent this, the tips of the new shoots are pinched off when they reach the desired height, usually in June. This throws the growth into the side branches, thus making sturdy, compact, self-supporting bushes. The black raspberry is usually headed at from 18 to 24 inches and the purple raspberry about 6 inches higher. If the shoots are headed much higher, the bushes tend to become top heavy with the weight of the fruit the following year and considerable bending over and breakage of canes result. The tip should be pinched off when the shoot reaches the desired height; and since all canes will not reach that height at the same time, it is necessary to go over the field several times during the season.

If the shoots are allowed to grow much above the desired height and are then cut back, this growth will be wasted and the branches will not be so strong as when the shoots are headed promptly. The tips may be pinched off with the fingers, cut off with knife or pruning shears, or lopped off with a sickle.

As with red raspberries, the old canes of black and purple varieties are generally removed soon after the crop is harvested unless needed for support during the winter. Under certain conditions, such as a dry soil or a dry season, immediate removal of the old canes may conserve some moisture. Conversely if there is an excess of moisture in the soil, leaving the old canes until the end of the season tends to reduce the excess of water and thus assists in ripening the new wood.

At the spring pruning, which is best done in March or early April after the severe cold weather is past, the weak canes are removed and the fruiting laterals headed back. As a general rule, all strong canes, that is, those more than $\frac{1}{2}$ inch in diameter, are left since the average plant can support all the canes of value for fruit production that it produces. If it is desired to reduce the amount of fruiting wood still more, it should be done by shortening the laterals rather than reducing the number of strong canes. It has been shown by investigations at the Michigan Experiment Station that it is profitable to leave a large number of canes to the acre even though there may be an actual reduction in yield per cane from crowding. Cane yield was not reduced by crowding where the number of canes left did not exceed 5500 to the acre. In one field on a strong soil it was considered that as many as from 8000 to 9000 canes to the acre could profitably be left for fruiting. A further advantage of having a large number of canes to the acre is the support they tend to afford each other, thus reducing injuries from high winds.

Other studies at the Michigan Experiment Station indicated that the laterals might be cut back severely at this pruning without materially decreasing the total yield. The total number of berries was reduced, but the size of the berries increased enough so that the yield was about the same as where the laterals were left much longer. Practically all of the buds on a black raspberry cane, except the basal four or five, are potential fruit buds. Short pruning stimulates all of the remaining buds to fruit production, increases the proportion of fruit borne by shoots arising from the main cane, and reduces the proportion borne by shoots arising from the laterals. The best results were obtained by reducing the laterals to a length of from 4 to 6 buds. This short pruning also tended to increase the proportion of berries ripening early and reduced the time of harvesting as much as 30 to 40 per cent. Short pruning also tended to minimize the effect of drouth. On very fertile soils with an abundant supply of moisture it may be possible to leave the laterals somewhat longer with beneficial results. At the Ohio Experiment Station laterals were left as long as 8 to 12 buds to good advantage. The laterals on the purple raspberry may be left as long as 10 to 14 inches.

VARIETIES

Productiveness is all important in varieties for commercial planting. It matters not how desirable a variety is in other respects, since any increase in price for superior quality rarely is enough to compensate for low yields. Inherently unproductive varieties cannot be made productive by any system of management that is profitable. Cuthbert, a high-quality variety, has given way to the heavy-yielding Latham. Winterhardiness is equally important as the reduction in the crop is proportional to the amount of winter injury of the canes. Losses from winter killing may be reduced somewhat by proper management of the soil, and often by care in the selection of a site. Most of the varieties grown in New York are hardy enough to withstand average winter temperatures if properly managed.

Virus diseases have long been a source of trouble in raspberry growing, and crops as well as the life of the planting have often been reduced by their ravages. Fortunately, several varieties that rarely become infected with mosaic are now available. Milton, Marcy, and September nearly always escape infection, even in the Hudson Valley where mosaic spreads rapidly. In the central and western part of the State, mosaic spreads slowly in Newburgh; but in the Hudson

Valley, Newburgh soon becomes infected. If several varieties are to be planted near each other, it is important that the virus relations of each variety be known so that susceptible varieties are not planted near carriers of the virus, such as the Columbian raspberry.

Growth habit determines whether trellising or staking is necessary. With some varieties the fruit is borne out in the open where it is easily seen by the pickers. This makes for cleaner picking and fewer overripe berries in later pickings. The berries of varieties that pick hard or cling to the bush are easily damaged by careless pickers.

The berries should be large, firm, and bright red in color. Berries that darken quickly after picking are discriminated against on the markets. Another serious fault is a tendency for the berries to crumble and break apart easily on picking. High quality is desirable but not essential in a market variety. A large bright red variety that is fair or good in quality will sell faster and at a higher price than a less attractive but higher quality berry.

The season of the variety should be considered in relation to the time of ripening of the major part of the crop in the same district. If Newburgh and Latham are the principal varieties grown, September which ripens several days earlier will be ready for market when the higher early season prices prevail. If the market is well supplied from another earlier district, a grower should consider the possibilities of growing a late variety. An early variety has a slight advantage in ripening before drought and high temperatures can cause much damage. Where berries are to be sold to the factory, the variety should ripen when the factory is not busy with other products.

Some processors have special variety preferences and these should be ascertained if the crop is to be used for jam, canning, or freezing.

A few growers in each section should test new varieties. Several experiment stations are breeding raspberries and some of them will undoubtedly be good enough to replace the present standard varieties. The Geneva Station from time to time suggests new varieties that are worthy of trial. Varieties from distant regions should be purchased with caution and only when recommended by someone who has grown them under conditions similar to those where they are to be set out. Catalog descriptions are sometimes based on the performance of the variety under conditions very different from those where the variety is to be grown.

Newburgh, Latham, and Taylor are the principal varieties of red raspberries grown in this State. June and Ontario are grown to a limited extent for the early market. Milton is still under trial as a

new variety and there are no large plantings yet. Indian Summer has been grown extensively for the home garden.

Bristol and Dundee are replacing Cumberland in the Finger Lakes counties and are increasing in the other areas. Shuttleworth is important in Erie and Chautauqua Counties. Logan and Morrison are also grown to a limited extent.

Sodus is the leading purple raspberry, with Columbian second in importance and decreasing in acreage. The acreage of Webster is increasing in Erie and Chautauqua Counties. Marion is being tested commercially and plantings are increasing.

The variety descriptions that follow are based on tests at Geneva, observations in the plantings of growers, and the reports of growers and other experiment stations. The varieties are arranged in order of ripening.

RED RASPBERRIES

June. Fruit is of medium size, roundish, bright, attractive red, rather soft, only fair in quality. Plants are of medium height, moderately vigorous, usually making only a medium number of suckers, productive, fairly hardy, very susceptible to mosaic. Canes are thornless and bear fruit out in the open.

June, grown occasionally as an early variety, has been profitable on markets where its earliness commands a premium. September is slightly earlier and superior in other respects.

Ontario. This variety, grown chiefly in Erie and Chautauqua Counties, is so similar to June that a separate description is not necessary.

Indian Summer. This variety has been widely grown in home gardens, but September appears to be much superior and should replace Indian Summer.

September. Fruit is of medium size, roundish, firm, bright red, attractive, of fair quality in summer but good in fall. Plants of medium height, vigorous, suckering freely, productive, and hardy. The rate of spread of mosaic in stocks of September is not known, but infected plants have been seen.

September, introduced in 1947, is a promising new autumn-fruiting or so-called everbearing variety that is worthy of trial for home use and for commercial planting. The fall crop, which is borne on the tips of the current season's canes, begins to ripen about September 1 at Geneva, or from two to four weeks earlier than the fall crop of Indian Summer. The summer crop ripens earlier than that of any other good red variety.

The principal fault of September is the tendency for the berries to cling to the plant, making picking somewhat difficult until the

berries are fully ripe. The quality of the summer crop is only fair. Desirable features are the earliness and firmness of the berries and the productiveness of the plants.

September appears to be superior to Indian Summer, particularly in the earliness of the fall crop and its freedom from crumpling.

Newburgh. Fruit is very large, roundish, medium red, usually fairly bright and attractive but occasionally rather dull, very firm, mild in flavor, good in quality. Plants are medium in height, increasing rapidly by suckers, somewhat prickly, very productive, hardy. This variety is rarely infected with mosaic except in the Hudson Valley; symptoms of mosaic are distinct, facilitating roguing.

Newburgh is now well established as a standard midseason variety for market purposes. The large size and unusual firmness of the berries, the productiveness of the plants as well as their freedom from mosaic, makes Newburgh worthy of consideration by all who grow raspberries for market. It is particularly recommended for growing with black raspberries.

Newburgh plants are of only medium height, and because of the long fruiting laterals and the heavy crop may need support. Growers frequently fail to cut back the canes of this variety at the spring pruning because they are shorter than those of other red varieties. This is a mistake; the canes should be cut back or they will bear more fruits than the plants can mature. The result will be small berries that may pick hard or even dry up without ripening, especially under drouth conditions. Newburgh at best tends to pick hard, but to some extent this fault may be counteracted by training the pickers to pick only the ripe berries, by cutting back the canes about one-fourth to one-third at the dormant pruning, and possibly by the liberal use of nitrogenous fertilizers in the early spring. Newburgh is at its best in seasons of abundant rainfall. In New Jersey and New England near the coast, it has been subject to considerable winter injury, but in colder regions, such as northern New Hampshire and Montreal, Canada, its true hardiness has been demonstrated.

Taylor. Fruit is large, long conic, bright attractive red, firm, sub-acid, good in quality. Plants are tall, vigorous with sturdy, heavy canes, increasing rapidly by suckers, productive, hardy, moderately apt to contract mosaic and show distinct symptoms. Taylor is worthy of trial for market and home use. The heavy yield of bright red berries, their firmness and good quality, borne on sturdy upright plants that do not require support, are characters that distinguish this variety. The plants are nearly as hardy as those of Latham at Geneva.

Latham. Fruit is large, roundish, attractive, light red but turning

dark when over ripe, moderately firm but inclined to crumble, mild in flavor and poor in quality. Plants are tall, vigorous, increasing rapidly from suckers, productive, hardy, subject to mosaic, but the plants endure the disease well under good cultural conditions, also very susceptible to mildew. Latham is the most widely grown variety of red raspberries in the country as a whole. Its past popularity has been due largely to its vigor, productivity, and ability to thrive over a wide range of conditions and in spite of diseases. Because this variety so frequently harbors mosaic and the disease spreads rapidly from it, Latham plantings should be kept at least 200 yards away from black raspberries and from mosaic-susceptible red varieties, such as June, Viking, and Taylor. The inclination for Latham berries to crumble is accentuated when the plants have mosaic or are grown under unfavorable conditions.

Milton. Fruit is large, long conic, bright attractive red, firm, subacid, good in quality, late. Plants are tall, vigorous, sturdy, and self-supporting, increasing rapidly by suckers, and are productive. Milton as grown in mosaic test plats in the Hudson Valley for ten years has remained free from mosaic. Under the same conditions susceptible varieties usually become infected in two years. Milton is worthy of trial for market and home use as a possibility for replacing Taylor, Latham, and Marcy. Its freedom from mosaic suggests that it may be of special merit in the Hudson Valley and for other sections where it is desired to grow black and purple raspberries in the same field.

BLACK RASPBERRIES

Shuttleworth. Fruit is above medium size, roundish, attractive, firm, and of good quality. Plants are above medium height, vigorous, hardy, productive, and moderately tolerant of green mosaic. This variety, although not outstanding in any one character, is probably about the best extra early variety and may well be planted for that reason. It is grown chiefly in Erie and Chautauqua Counties where it was at one time distributed under the name of Plum Farmer.

Evans. Fruit is large, roundish, an attractive glossy black, only fair in firmness, and very good in quality. Plants are tall, vigorous, productive, hardy, not enduring mosaic well. Evans, ripening with Bristol, is slightly more attractive, softer, and possibly less productive than the variety. It is well worthy of trial, particularly for home use.

Logan. Fruit is of medium size, roundish, black, glossy, firm, good in quality but tending to sourness in dry seasons. Plants are rather slow-growing with small canes, moderately productive, hardy. Logan is not the equal of other varieties of its season and its culture

in New York is not recommended. Its chief merit is immunity to leaf curl, a relatively rare disease in this State.

Bristol. Fruit is large, roundish, conic, black, moderately glossy, attractive, firm, and very good. Plants are tall, vigorous, hardy and very productive, enduring mosaic fairly well. Bristol, introduced by this Station a few years ago, has become an important variety and is one of the best for market and home use. The special features of Bristol that recommended it are the productiveness and vigor of the plants.

Dundee. Fruit is large to very large, roundish conic, attractive glossy black, firm, sweet, very good to best quality. Plants are tall, vigorous, productive, hardy, acquire green mosaic readily but endure the disease well, with symptoms not distinct. Dundee is a high-quality, handsome, large-fruited variety well worthy of trial for market and home use. It ripens midway between Bristol and Naples.

Cumberland. Fruit is large, conic, attractive, black, firm, sweet, and rich in quality. Plants are tall, vigorous, hardy and productive, very subject to anthracnose and all of the virus diseases. Cumberland, ripening a few days later than Plum Farmer, is of high quality and attractive appearance and of the standard sorts is easily the best of its season. The prime weakness of this variety is its susceptibility to diseases.

PURPLE RASPBERRIES

Sodus. Fruit is unusually large, roundish conic, purple, attractive, firm, not crumbling, rather tart, good. Plants are tall, very vigorous, growth habit like black raspberries and propagating by tip layering, very productive, hardy, moderately subject to mosaic, of which the symptoms are distinct.

Sodus is a promising purple raspberry that should replace Columbian. As compared with Columbian, Sodus berries are larger, firmer, more attractive, and do not crumble. Sodus is more acid and not so good in quality, but limited tests indicate that it makes a good canned product. The plants of Sodus are more vigorous, hardier, more drouth resistant, and considerably more productive than those of Columbian. Its relative freedom from mosaic is an important reason why Sodus should be preferred to Columbian.

Columbian. Fruit is medium size, roundish, dull purple, and only moderately firm, inclined to crumble, sprightly, good quality. Plants are tall, vigorous, upright, with growth habit like black raspberries and propagating by tip layering. Columbian is the standard and most widely known purple raspberry, being popular for jam and canning. All stock of this variety is uniformly affected

with green mosaic, symptoms of which are very mild. It should not be grown near black raspberries or mosaic-susceptible red and purple varieties. Yellow mosaic produces pronounced symptoms on Columbian.

Webster. Fruit is of medium size, roundish, dark purple, firm, good, ripening with Columbian. Plants are low growing, moderately vigorous, hardy, and very productive. Webster was introduced in 1926 but did not attract much attention until recently when growers in Erie County began increasing their plantings of it. The firmness of the berries and productivity of the plants appear to be the principal reasons for its popularity. Pickers like Webster as the berries are mostly on the outside of the plant where they are easily reached.

Marion. Fruit is very large, retaining its size well throughout the season, roundish conic, dull purple, firm, tart, good, ripening about a week later than Sodus. Plants are vigorous, hardy, and very productive, propagating by tip layering and very sparingly by suckers. The plants are susceptible to orange rust. Marion is unusually large and productive and its planting is on the increase. It is well worth testing for commercial purposes, especially by growers who want a variety ripening later than Sodus.

DISEASES AND THEIR CONTROL

Infectious diseases in raspberries may be caused by viruses, fungi, or bacteria. In addition, various non-contagious injuries produced by adverse weather and soil conditions which may complicate the diagnosis of infectious diseases are common. A grower of raspberries should be able to diagnose the troubles that may occur in his planting so that the planting can be kept healthy. The important diseases found in New York State are discussed in the following paragraphs.

VIRUS DISEASES

Diseases caused by viruses have been the cause for the degeneration or "running-out" of raspberry stocks and varieties so common in the past. Two of the six raspberry viruses cause the mosaic diseases that occur most frequently in New York State.

All of the raspberry virus diseases have certain characteristics in common. Infected bushes never recover. All parts of an infected bush eventually become diseased. All stock propagated vegetatively from infected plants is also infected.

The raspberry viruses are spread from diseased to healthy plants

only by the feeding activities of insect carriers. All of the known carriers are a few species of aphids or plant lice that feed solely on plants of the genus *Rubus*. None of the raspberry viruses, in consequence, infects plants of other genera; nor, so far as observations and experiments to date have indicated, are any of the numerous viruses of other plants transmissible to raspberries. Raspberry mosaics, curls, and streaks are not spread by pruning or other cultural operations, except as these operations may spread the carrier aphids.

Mosaics

Two raspberry mosaics are recognized and are designated as *green mosaic* and *yellow mosaic*. Both mosaics are present in all of the berry-growing sections of this State. Green mosaic is the more common mosaic in black and purple raspberries. Both mosaics are abundant in red raspberries, not only in cultivated plantings but also in the wild stocks.

The basic symptom of mosaic infection is a mottling of the leaves (figure 1). Light green or yellowish spots are present in the normal or darker green leaf color. The intensity of mottling varies from a barely noticeable speckling to a severely "blistered" state or to an all-yellow condition. An infected plant may express mottling on only a few leaves, then again most or all of its leaves may be mottled. The type and degree of mottling varies with several conditions, including variety of raspberry, virus present, vigor and stage of plant growth, part of the plant, stage of infection, time of season, and weather conditions.

The two mosaic diseases can be distinguished from one another with relative ease and accuracy in black and purple raspberries, but only with difficulty and sometimes not at all in red raspberries. A true mottle pattern of light green and dark green blocks with a tendency to blister in susceptible varieties is generally characteristic of green mosaic. The leaf discoloration evident in yellow mosaic, on the other hand, is typically a general yellowing of tissues spreading from along the veins outward and from the margins inward. While reduced leaf size accompanies the mottling of green mosaic, there is little or no deformity in the leaves. Yellow mosaic causes leaflets to be not only smaller but narrower and to be cupped, downward or upward, as though the margins had not kept pace with the centers during growth. Green-mosaic mottling is seen most commonly and plainly on the lower or first leaves of the fruit spurs and on the lower leaves of the new shoots, whereas yellow mosaic

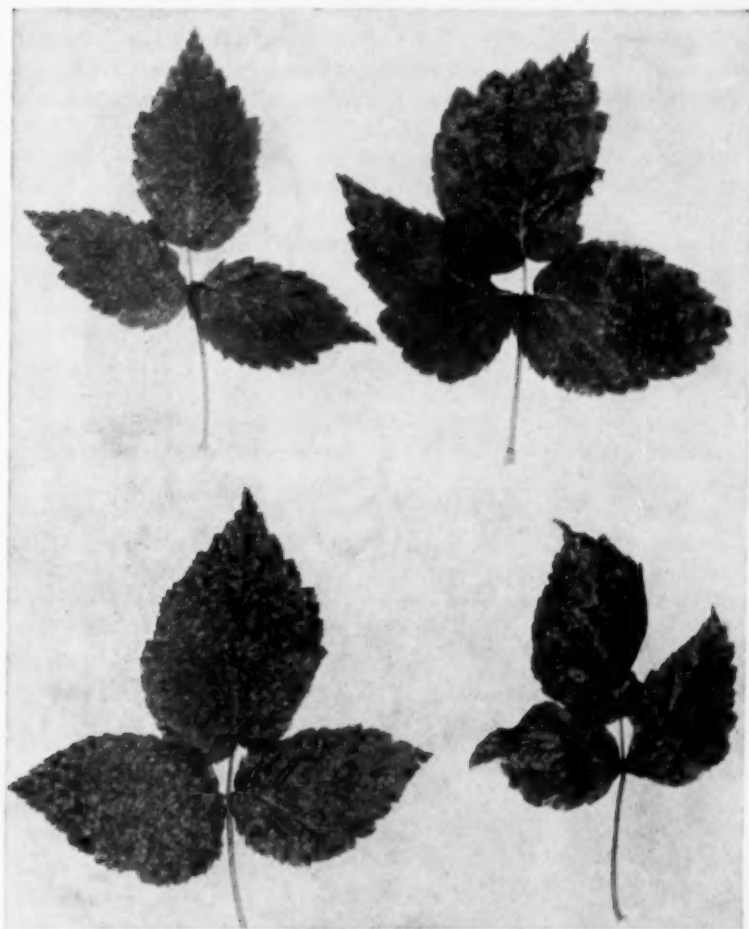


Photo by W. R. Fisher

FIGURE 1. VARIOUS TYPES OF MOSAIC MOTTLING ON RASPBERRY LEAVES

is expressed on the upper leaves of the fruit spurs, just under the blossom clusters, and on the higher leaves of the new shoots. In black and purple raspberries, yellow-mosaic infection typically causes more stunting and more rapid degeneration than green mosaic. Frequently both mosaic viruses may be present in the same raspberry plant.

In black raspberries, a new infection by either mosaic virus shows up in a stoppage of growth on the new-shoot tip where the carrier



Photo by W. R. Fisher

FIGURE 2. EFFECTS OF MOSAIC INFECTION ON CANE TIPS OF BLACK RASPBERRY

aphid fed, followed by a blackening and bending of the cane tip (figure 2). Leaves just back of the tip are stunted and mottled. The tip may die or it may grow through the initial shock. The virus travels rapidly within the plant and in a short time all the other new-shoot tips on the same plant will express the mosaic infection in a similar manner. In extremely susceptible varieties such as Plum Farmer, this death of new-shoot lateral tips will recur every summer on most of the old as well as the new infections of green mosaic. In black raspberries, too, the majority of green mosaic cases are several days slower in leafing out in the spring than are normal healthy plants (figure 3).

As a general rule, raspberry-mosaic symptoms are most clearly visible in spring and early summer, that is, during late May, June, and early July. The leaves produced during this period, and again in early autumn, show the mottling most clearly. Green mosaic shows up earlier in the spring growth of infected plants and at lower temperatures than does yellow mosaic. Mottling of both mosaics is suppressed, often masked entirely, on foliage grown during hot, summer weather.

The natural spread of both raspberry mosaics is accomplished almost exclusively by one species of insect, the large, pale-green, leaf-feeding, raspberry aphid. This aphid, even when feeding in great numbers on a single plant, causes no noticeable injury. It assumes economic importance only in its role as a mosaic virus

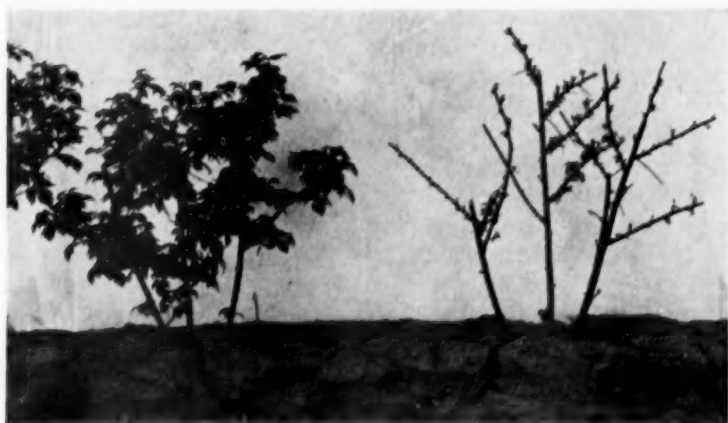


FIGURE 3. DELAYED LEAFING-OUT OF A BLACK RASPBERRY PLANT IN THE SPRING, CHARACTERISTICS OF GREEN MOSAIC INFECTION

carrier. It is quite specialized as to hosts, feeding readily only on raspberries and occasionally on blackberries and dewberries. The large raspberry aphid shows decided preference for certain varieties of raspberries and just as decided dislike for others. This aphid is exceptionally numerous in the Hudson Valley region. In the Lake Erie section in favorable seasons and on certain preferred varieties, such as Latham and Ontario, large populations of the aphid are built up in early spring and summer and again in the autumn. This insect is least abundant, apparently, in the Finger Lakes and central New York areas.

Some raspberry varieties escape serious mosaic infection; others contract mosaics with extreme readiness. There are all gradations between these extremes. Besides, raspberry varieties vary to both extremes in regard to the effect mosaic infection has upon them. Black raspberries, as a group, tend to be injured by mosaic infections. Plants of Plum Farmer, which is representative of very susceptible varieties, may be dwarfed to worthlessness or killed outright within a year after infection. Mosaics will spread readily in Cumberland and Shuttleworth, but infected plants may endure several seasons before final collapse. Red raspberry plants seldom die as a result of mosaic infection alone, but height and diameter of canes and vigor of crowns and roots are reduced in varying degrees (figure 4). Under good culture, plants of a tolerant variety, such as Latham, may still yield profitably after several years of infection. The more susceptible red varieties, such as Ontario, June, Viking, Marlboro, Perfection, and Cayuga, cannot be maintained on a paying basis if mosaic infection becomes extensive. Stocks of all the older purple raspberry varieties, of which only the Columbian is widely grown, are entirely infected with green mosaic but are naturally highly tolerant to its effects. Yellow-mosaic infection is more harmful in purples.

The varieties of raspberries may be classified on the basis of the ease with which they contract the mosaic disease. Most of the varieties are susceptible and become diseased readily. Newburgh and Chief are two varieties that usually escape serious mosaic infection. These varieties may be grown in most sections with little concern over mosaic invasion, but in the Hudson Valley many plantings of both Chief and Newburgh have become heavily infected. Of the mosaic-tolerant types, the Latham red raspberry and the Columbian purple raspberry are most widely grown. The Chief may be included with this class also. Even though Latham is mosaic-tolerant, infected plants tend to produce lighter crops of smaller and crumbly berries.

Even with a mosaic-tolerant variety and in a section where mosaic spreads rapidly, new plantings will pay best if started with mosaic-free stock. Recent experience with seedling purple raspberry stocks where healthy plants were available for comparison, indicates that mosaic infections cut down the growth and productivity of even this tolerant species from 20 to 50 per cent. Three varieties of red rasp-



Photo by W. H. Rankin

FIGURE 4. EFFECT ON NEW CANE GROWTH OF MOSAIC INFECTION IN A RED RASPBERRY PLANT

berries (Milton, Marcy, and Indian Summer) remained free of mosaic during ten seasons of extreme exposure to mosaic in the seedling and variety test plats in the Hudson Valley and in Erie County.

The spread of mosaic from infectible but tolerant sorts into nearby susceptible stock of other varieties is apt to be rapid and damaging. Because of this circumstance, one seldom sees black raspberries or June, Viking, or Cuthbert red raspberries thriving on the same farm with Latham or Columbian plantings. For growing with black raspberries, the Milton, Marcy, September, or Newburgh red raspberries and the Marion purple variety are especially recommended.

Control

The simplest way to prevent undue losses from mosaics in raspberries is, of course, to grow varieties that do not become diseased. In regions where mosaic is troublesome, Milton, Marcy, and September should be satisfactory. In other regions where mosaic is not so prevalent, Newburgh, Chief, Taylor, or Latham would also be satisfactory.

Methods designed to curtail the spread of mosaic viruses into and within raspberry plantings still must be the chief reliance of most growers, especially those that grow black raspberries. The basis of such a program is the elimination of infection sources. Three points are to be observed as follows:

1. Obtain certified stock that is as mosaic-free as possible to make new plantings. This practice always pays even though no subsequent efforts are made to maintain the plantings virus-free.
2. Isolate this stock from outside sources of disease. The greater the distance of isolation the better; 30 rods in all directions should be regarded as a minimum and 60 rods is highly desirable. Other cultivated raspberry plantings will be the principal source of mosaics in most sections, but wild red raspberries often harbor these diseases and the eradication of such wild hosts is essential. In the older and more intensive raspberry growing regions, individual farmers often cannot obtain for their plantings the necessary isolation from mosaic sources without concerted community action.
3. Inspect and rogue plantings regularly, especially during their first few years, to eliminate internal mosaic infections from which spread can take place. In red raspberries, two inspections should be made, one about mid-June and a second during the latter part of September. Three inspections are desirable in black and purple

raspberries, in late May or early June, in early July, and in September. In black raspberries, an inspection late in April to detect green mosaic cases through their delay in leafing out may save much labor later.

Every grower should so verse himself in the knowledge of mosaic symptoms in his varieties at different stages of infection and at different seasons that he can competently inspect his own fields. It is of prime importance that mosaic infections be recognized in their earlier stages. Infected bushes should be dug promptly, and removed before they wilt in such a manner that the mosaic-carrying aphids are not dislodged and scattered about the fields. Wrapping plants in canvas or burning the foliage prior to digging are worthwhile practices. It is not necessary to rogue plants in the row adjacent to those infected if the inspections are made systematically. In roguing red raspberries, all the roots and rootstocks of the infected plants must be grubbed out completely.

Inspection and roguing of raspberry plantings for mosaic is not advised unless external sources of infection have been removed. Taking out diseased bushes within a planting is a waste of time and energy if invasions from outside continue unmitigated.

In raspberry inspection for mosaic control it is highly important not only to know definite mosaic symptoms, but also to know injuries of another nature that may be confused with the mosaic. Very early in the growing season, frost injury on the first few leaves produced on the fruiting-cane spurs may simulate mosaic mottling. Frost markings can usually be distinguished, though, by the characteristic crimping of the leaves and the fine white lines drawn along the sides of the main veins. Frost or cool-weather mottling is especially common and deceptive on foliage of Ontario, June, and Cuthbert varieties. If frost injury has been extensive on the early leaves, the first mosaic inspection might better be postponed a few days until new foliage has been produced. In mid-summer, the fine, gray stippling on raspberry leaves caused by the feeding of red spiders may be mistaken for mosaic symptoms. At this same season, also, powdery mildew infections on shoot tips may produce symptoms similar to those of recent mosaic infections; and on older leaves, spots resembling mosaic mottling. Spider injury and mildew infections may be distinguished by the evident presence of the parasites themselves. Mosaic inspections are best conducted at a season just after frost injury has passed and before red spider and mildew damage appear.

Leaf curls

In this State, the leaf-curl diseases are met with occasionally in almost all sections but are not common anywhere. Two viruses are concerned, one of which infects only red raspberries, chiefly the variety Cuthbert, while the other is capable of infecting black as well as red varieties. Purple raspberries may be considered immune to leaf curls. Two black raspberry varieties, Plum Farmer and New Logan, never become infected.

The name *leaf curl* adequately describes the symptoms of these diseases, which are always striking (figure 5) and are evident throughout the growing season.

The spread of leaf curls from diseased to healthy plants is carried on exclusively by the small raspberry aphid. Full-grown adult aphids of this species are no larger than a pinhead. This aphid feeds on the undersides of leaves anywhere on the raspberry plant. It is inactive, each individual usually spending its entire life on the particular leaf where it was born. Winged adults, however, because of their small size and light weight, may be carried considerable distances by air movement, and leaf curls have been known to spread over spans of several hundred yards.



FIGURE 5. LEAF CURL SYMPTOMS ON CUTHBERT RED RASPBERRY
Left, fruiting cane; right, new shoot tip.

Control

Because their symptoms are so unmistakable and because the carrier aphid is inactive, leaf curls are readily controlled by the inspection and roguing program for mosaics.

Streaks

Two virus diseases of the streak type also are distinguished. They are designated mild streak and severe streak. Both affect only black raspberries. Mild streak is quite common in the Finger Lakes region. Severe streak is present to some extent in all varieties and everywhere in the State where black raspberries are grown, but has been the most prevalent in the Lake Erie fruit belt.

The principal symptom of the raspberry streak diseases, and the one from which their name is derived, is the numerous stripes on the sides of the canes (figure 6). With mild streak, these stripes are narrow, fine lines, steel-blue or gray-blue in color. In severe streak the stripes are deep blue or purplish and wider. After the bloom has been rubbed off the canes, the stripes appear as brown, dead areas in the bark. Both diseases are characterized by a peculiar growth of

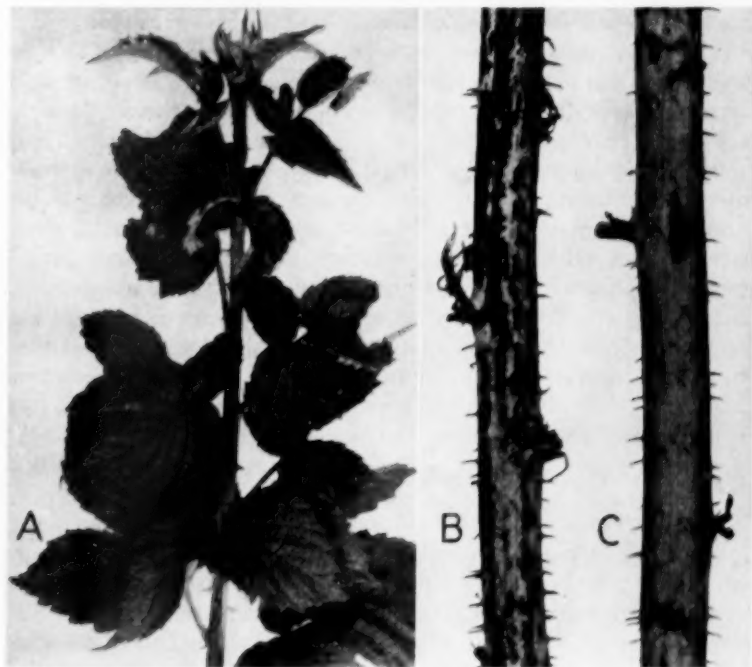


FIGURE 6. SYMPTOMS OF STREAK ON BLACK RASPBERRY

A, the tip of a new shoot from an affected plant, showing typical bending or recurvature of leaflets; B, a section of a new cane from an affected plant, showing characteristic streaks compared with (C) a similar section of a cane from a healthy plant. (Photograph from Michigan Agricultural Experiment Station)

the leaflets on the tips of the new canes (figure 6). The midribs of the leaflets are hooked, or recurved, and twisted. This is the first symptom visible on affected plants each season, and is also the first indication of a new infection. Plants affected with severe streak can be recognized at a distance by the pronounced yellowish splotching of the older foliage and a droopy appearance of the whole plant. This disease causes a serious stunting of the bushes, progressive from season to season, and the berries produced on diseased plants are soft, dull in appearance, and insipid in flavor. Mild streak black raspberry plants are nearly as vigorous as virus-free plants, but the fruit produced on them is so inferior that it is not marketable. Symptoms of the streak diseases are most apparent in mid-summer or later, although in some seasons they have been observed in late May and early June.

Spread of the streak disease is extremely rapid in some instances and very slow in others. Mild streak plants propagate readily by tip layering, but those affected with severe streak for as long as one season produce almost no tip-plants. In sections where severe streak spreads slowly, then, the disease tends to die out of itself through the decline of affected plants.

All evidence from studies of field spread indicates that the streak diseases are transmitted by insect carriers. Practically all species of insects that feed on raspberries have been experimented with extensively by several investigators, however, and still the streak carrier remains undiscovered. Experiences in several States in recent years have indicated that rapid spread of streak in black raspberry plantings is associated with the presence of blackberries, either wild or cultivated, in the vicinity. Presumably, the carriers of streak are harbored in the blackberries from whence they migrate into the black raspberries, distributing the virus in their feeding.

Control

In most instances, the streak disease can be eliminated from black raspberry plantings by systematic inspection and roguing. Inspection for streak can be carried on with mosaic inspections, as recommended. Where these diseases are common, an additional inspection when the fruit is ripe is advised. Affected plants should be dug out with care to avoid dislodging possible insect carriers of the disease.

If streak persists in spite of inspection and roguing, all blackberries, both wild and cultivated, in the vicinity of the black raspberries should be eradicated.

FUNGOUS DISEASES

Numerous fungi, or "molds", are able to infect growing raspberry plants and cause different kinds of diseases. These diseases may occur on various portions of the plant, such as roots, canes, leaves, or fruit. Only the important fungous diseases are discussed.

Anthracnose

In practically every raspberry planting, and in every season, anthracnose or "cane spot" (*Plectodiscella veneta* (Speg.) Burk.) can be found. It is typically a disease of black and of certain varieties of purple raspberries, although it is not uncommon in red raspberries. Anthracnose becomes of widespread economic importance in rainy seasons and on certain varieties.

For black raspberries, the characteristic symptom on the canes is a round or oval gray "scar" with a brown, reddish, or purple border (figure 7). Each scar results from a separate infection by the fungus and may vary in size from a spot barely visible to one that is $\frac{1}{2}$ inch in diameter. Canes are infected in their first season before the bark tissues are matured. The scars are commonly in clusters, marking rain periods that made spore germination and infection possible. Spots may be found also on leaves, leaf petioles, and, in fact, on all aerial parts of the raspberry plant. Anthracnose may cause a dry rot of the fruit. Individual drupelets may dry up causing the fruit to become misshapen. Infected fruits may turn partially or wholly brown and dry.

Anthracnose spots on red raspberry canes are usually very small. When cane infections on this host are numerous, the fungus grows extensively throughout the bark, producing the so-called "gray-



FIGURE 7. ANTHRACNOSE SPOTS ON NEW SHOOTS OF BLACK RASPBERRY

bark" phase in autumn. Individual drupelets of the red raspberry fruit may become infected, giving the fruit a one-sided or deformed appearance.

While heavy infections on new canes can stunt them seriously or kill them outright, ordinarily the cane infections are superficial and not so harmful as they are noticeable. If they are large enough, though, or if several spots coalesce, affected canes may crack open during winter and, in their fruiting year, dry out or break off. Canes weakened by anthracnose are more susceptible to winter injury. Fruit infections sometimes cause serious loss of crop, especially in the Cumberland black raspberry. At times the leaf-spotting phase is so prevalent on fruit-spur foliage of black raspberries that there is defoliation and the fruit does not ripen normally.

Both of the older, standard varieties of black raspberry, Plum Farmer and Cumberland, become infected with anthracnose readily. On the other hand, Quillen is almost immune to anthracnose infection and Naples, although somewhat subject to the disease, has proved commercially resistant to anthracnose under conditions favoring epidemic development of the disease. Where anthracnose is a serious problem in black raspberry culture, these varieties should be tried. Of the purple varieties, Columbian and Webster are extremely susceptible to anthracnose infection, while Sodus and Marion are virtually immune to this disease. Among red raspberries, anthracnose is most common in Latham, June, and Ontario, while Newburgh, Taylor, and Marcy are less seriously affected.

Control

Damaging anthracnose infections are to a large extent preventable by cultural means. In making new raspberry plantings, the grower should avoid locations where heavy dews are frequent or where rain does not quickly evaporate from the canes and leaves. Plantings should be kept cleanly cultivated from May until late July each year, as weed growth in the rows stops air circulation about the canes and prevents rapid drying after rains. The raspberry canes are thinned at the time of spring pruning to keep out surplus growth that also retards aeration. In this thinning-out process, the grower should remove especially the canes most heavily infected and most weakened by anthracnose. Maintaining soil fertility to obtain rapid early growth of new canes in the spring reduces anthracnose damage. In setting out black and purple raspberries, the old-cane stubs should be pruned off the tip plants. This practice will reduce the amount of anthracnose fungus present in the new field

and will curtail the disease for the first year or two. In planting red raspberries, canes which have considerable anthracnose should be discarded.

Where anthracnose does prove consistently injurious, the disease can usually be controlled by one spray applied thoroughly each spring. Liquid lime-sulfur, 4 gallons in 100 gallons of water, is recommended. Application should be made to the canes as a "delayed-dormant" spray, when the second and third leaves are expanding. The effectiveness of this spray depends on killing the fungus or retarding its development in the old scars on the canes. In plantings where anthracnose is especially difficult to control, additional protection of the new growth and fruit can be obtained by spraying with ferbam, 2 pounds in 100 gallons of water, when the new canes are from 12 to 15 inches high and again just before bloom. Most of the benefit derived from spraying to control anthracnose is not apparent until the following year, when the disease-free fruiting canes bear.

Spur blight

Red raspberries are subject at times to serious losses from spur blight or "purple cane spot" (*Didymella applanata* (Niessl.) Sass.). Dark blue or purplish oval spots around the buds are evidence of the presence of this disease. By the following spring, the diseased areas are gray in color. Spur blight may kill the canes or weaken them so they are susceptible to winter injury; if the cane lives, buds within the diseased areas are killed or weakened so they produce no fruit. In any case, the stand of healthy fruiting canes is materially reduced. Observations of numerous plantings of red raspberries have indicated that spur blight does not usually become a problem until the planting is four or five years old.

There appears to be some difference in the susceptibility of the varieties of red raspberries to spur blight. The varieties Indian Summer, Taylor, Newburgh, and Latham become diseased readily, while such varieties as Marcy, Chief, Cuthbert, Viking, and Ontario do not contract the disease so easily.

Control

Dense growth of raspberry foliage, or of weeds, prevents proper drying of canes and leaves after rains and favors the spread of spur blight. Hence, this disease is best kept in check by growing red raspberries in the narrow hedge-row system, keeping the number of canes in the row properly spaced and maintaining scrupulously clean cultivation throughout spring and early summer.

If the above cultural measures alone do not provide control, spraying will be necessary. Results of recent experiments have indicated that a spray applied to the canes in the spring about the time that the buds show a green tip will control the disease. Either a 1 per cent solution of Elgetol or liquid lime-sulfur, 1 gallon in 10 gallons of water, should be satisfactory if the canes are thoroughly sprayed from both sides of the row. As an additional control measure the new shoots may be sprayed with ferbam, 2 pounds in 100 gallons of water, when they are about 12 to 15 inches high followed by a second application two weeks later. It must be remembered that the results from spraying for spur-blight control will not show up in the production of good fruiting canes until the year after the spraying is done, since the canes grow the first year and produce fruit the second year.

Red-raspberry plantings that appear to be practically killed out by spur blight and winter injury can be revived. Late in the spring, when it has been determined that the stand of healthy fruiting canes in the planting is too low for a satisfactory crop, the grower should cut off all the canes at the ground and burn them. Since the fungus is carried over winter on the diseased fruiting canes, the removal of the canes should eliminate the disease. The cane stubs remaining in the rows should then be sprayed with lime-sulfur 1-10. An excellent stand of new canes will be produced from the roots during the summer.

Mildew

Powdery mildew (*Sphaerotheca humuli* (D. C.) Wint.) affects all species and varieties of raspberries but is usually of importance only on the Latham red raspberry. During recent years powdery mildew has been unusually prevalent on black raspberries, especially in 1- and 2-year-old plantings. The Dundee variety is more susceptible than other varieties. The disease is generally prevalent in dry years and is worse in locations where air circulation is impeded.

Symptoms first noticed are the dwarfing and distortion of the tip leaves on the new shoots in early summer. Affected tips make a stunted, spike-like growth that may readily be mistaken for a recent green-mosaic infection. The water-soaked appearance and the powdery white coating covering parts of the cane tips and leaves serve to identify the disease. Sometimes numerous mildew infections on an older leaf may produce a mottling confusable with mosaic. Generally speaking, mildew is not a serious disease in raspberries.

Control

No direct control measures for mildew on raspberries are recommended. Dusts or sprays that are toxic to the powdery mildew fungus are highly injurious to raspberry foliage, causing more damage than good. Culture of the Latham variety should be abandoned if mildew losses become excessive. The disease does not appear to be serious in black raspberry plantings after the second year.

Wilt

A certain soil-inhabiting fungus (*Verticillium albo-atrum* Reinke & Berth.) that commonly causes a wilt disease of many vegetables, especially tomatoes, peppers, eggplants, and potatoes, also may infect the roots and stems of raspberries and cause a disease known as *wilt* or "blue-stem." While wilt is not a general disease in raspberries, it has caused heavy losses in scattered plantings throughout the State. In every instance traced, the disease has been in young plantings of raspberries set in fields where one or another of the above-named vegetable crops had been grown a year or two before. Wilt seldom invades established raspberry fields.

Typical wilt symptoms appear in midsummer. Affected plants cease growth, droop, turn yellow, and shed the basal leaves from the new canes. A broad blue stripe extends from the base upward on each cane. Mildly affected plants make a partial recovery in the fall, but their canes usually do not survive the winter.

No species or variety of raspberry is known to escape possible wilt attacks. Losses are usually heaviest in black raspberries because affected bushes die out entirely, whereas, in red raspberries, new crowns are constantly being formed to offset those lost by fungous invasion. If the amount of wilt developing in a new planting is small, the disease probably will cause but slight loss and may disappear entirely in a few years. Especially in those sections of the State where high summer temperatures prevail, raspberries are inclined to out-grow wilt infection.

Control

To prevent wilt, raspberries should not be planted on soils where tomatoes, peppers, eggplants, or potatoes have been grown within the previous three or four years. Nor should first-year raspberry plantings be intercropped with any of these wilt-susceptible vegetables. If a few plants or centers of wilt infection do appear in a raspberry planting, these should be dug out and burned promptly.

If the wilt occurrence in the planting is general, it would be advisable to remove the planting entirely and make a fresh start in the new location. Only healthy plants from a disease-free planting should be used for starting a new planting at any time.

Orange Rust

Orange rust (*Gymnoconia interstitialis* (Schl.) Lagh.) sometimes affects black raspberries but never reds or purples. The disease is named for the color of the spore masses of the causal fungus which cover the undersides of the leaves of affected plants during the latter part of May and the first part of June. Diseased plants may be detected in advance of spore production by the abnormally large number of spindly new shoots, their lack of prickles, and the general "staring," upright manner of growth. The leaves appear abnormal and yellowish areas may be noticed. The fungus grows within and throughout the entire system of each affected plant. Infected plants produce no blossoms or fruit and never recover. The disease is spread to healthy plants by the orange-colored spore dust.

Control

Spores of orange rust require a relatively lengthy period of wetting before they can germinate and infect new shoots of the black raspberry. As a consequence, good ventilation around the new shoots helps to prevent infection. Choosing sites for plantings where air movement is free and keeping weeds cleaned out of the raspberry rows are good rust-preventive practices. If there are rust infections, the diseased plants should be removed as soon as noticed and burned. It is preferable that this should be done before the orange dust appears on the leaves of the affected plants. Rust-infected wild black raspberries in the vicinity should also be eradicated.

Autumn Rust

Small yellow rust spots (*Pucciniastrum americanum* (Farl.) Arth.) may be seen on the undersides of the leaves, and occasionally on the canes of red raspberries in late summer and fall. Leaves that are heavily infected have their undersides covered with rust pustules and die and drop prematurely. Canes defoliated abnormally early in the fall are prone to winter injury. Latham is particularly subject to this disease, but the disease also attacks Ontario, Viking, and other varieties. Autumn rust, however, is of negligible importance ordinarily, and must not be confused with the orange rust of black

raspberries. It is not systemic and is usually not serious as the plants are not permanently diseased. Removing infected plants accomplishes no good.

Control

General sanitation and good air circulation to prevent infections are the only known control measures of value.

Fruit rot

During wet seasons many growers are troubled with a fruit rot. The berries may turn brown and dry up before they ripen or they may become rotten about the time they should be ripe. In other cases the fruit may be deformed because of the rotting of individual drupelets of the berry.

Fruit rot may be caused by various fungi. In black raspberries, if the fruit turns brown and dries up, the trouble is usually caused by the prevalence of anthracnose (*Plectodiscella veneta* (Speg.) Burk.) This disease will cause deformed fruit in red raspberries. Various molds (*Botrytis* Sp., *Fusarium* Sp., *Alternaria* Sp., and the like) may cause the fruit to rot about the time that the fruit becomes ripe. This is particularly true when there is excessive rainfall during the ripening season. This type of fruit rot may be found on black, purple, or red raspberries.

Control

The anthracnose type of fruit rot can be eliminated by applying the proper control for anthracnose as discussed on page 34. At present, there is no known control measure for the other type of fruit rot. If the season is abnormally wet, some measure of relief might be obtained by spraying the bushes with ferbam, 2 pounds in 100 gallons of water, when the fruit is about two-thirds grown.

BACTERIAL DISEASES

Bacteria cause a number of diseases in plants; however, with raspberries, only one type of disease caused by bacteria is of importance, namely, the gall diseases.

Galls

The raspberry gall diseases, common in all sections, are referred to as *cane gall*, *crown gall*, or *root gall*, according to the part of the

plant affected. Probably two species of soil-inhabiting bacteria are involved in their production. One, *Agrobacterium tumefaciens* (E. F. Sm. & Towns.) Conn., causes galls on the roots and crowns below the ground (figure 8). This is the same organism that causes the well-known crown gall on a variety of hosts, such as apples, grapes, peaches, roses, and the like. The second species, *Agrobacterium rubi* (Hildebrand) Starr & Weiss, causes galls on raspberry canes (figure 9) and crowns, mostly above ground, and attacks principally the black and purple species.

The spongy, rough, wart-like growths are produced anew each season. The size of the galls varies from a pinhead to 2 inches or more. The root-gall type develops underground in the early part of the growing season. Cane galls, present almost exclusively on the fruiting canes, make their appearance in mid-June. The moist outer surfaces of the fresh galls are covered with the bacteria which wash off into the soil. Both types of galls turn into brown and woody knots with age, then rot and slough off in the fall and winter.

Gall-affected plants are seldom thrifty and require the best of soil and weather conditions to make average growth and production. The galls obstruct the passage of food and water through roots, crowns, and canes, and divert a part of these materials to their own development. Canes with large or numerous galls usually split or break. In final stages, the gall growth completely smothers the crown

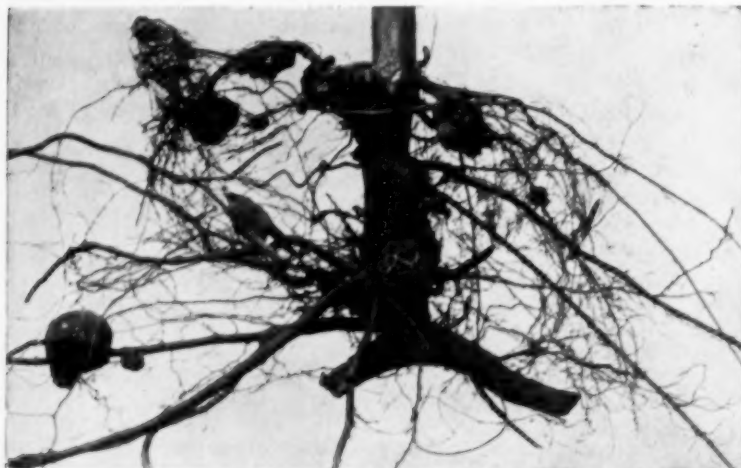


Photo by H. F. Eustace

FIGURE 8. ROOT AND CROWN GALLS ON A RED RASPBERRY PLANT

buds from which new shoots develop and the plant dies because of lack of cane renewal.

Control

The gall diseases of raspberry are most difficult to control. The causal bacteria may live in the soil several years. A wide variety of hosts and the fact that the organisms are already widely disseminated complicate the control question. No method of soil sterilization to kill the gall bacteria in the soil is available. Sanitary precautions to prevent the introduction of the gall diseases are the only recourse.

Soils apt to be infested with gall bacteria should not be used as sites for new raspberry plantings. Such sites are those where old bramble, vineyard, or tree-fruit plantings have been growing during the past several years, or those that have received drainage water from such plantings. Fields most apt to be gall-free are those where grain or vegetable crops have been grown.

Plants for setting new raspberry fields should be obtained preferably only from parent plantings in which there is no gall. Since this is not always feasible, growers should set only gall-free plants. Raspberry plants should be purchased only from reliable growers and nurserymen and from stock that has been inspected and certified by the regular State nursery inspection service. Even then, before setting, each plant should be examined carefully and any plant that shows evidence of gall infection should be discarded. Growers should bear in mind that few sucker plants or tip plants will have galls showing on them, even when such plants have been



FIGURE 9. GALLS ON FRUITING CANES OF A BLACK RASPBERRY PLANT

taken from a badly infected old planting, yet the gall bacteria will be numerous in the soil particles on these plants and will infest the soil of the new field. Also, the organisms will gain entrance into the roots and crowns of the young plants through the many small wounds made in the digging and setting operations. It is no uncommon circumstance to find, one year after setting, a high proportion of infected plants in stock that appeared gall-free at the time of setting. Inspection for gall diseases in raspberries should be made at plant-digging time in the field, not in the barn or warehouse, and the old parent crowns, canes, and roots rather than the young plants should be the subject of observation.

Since the gall bacteria are in the soil and infections take place through wounds, spread is increased by deep and careless cultivation, with its consequent injury to raspberry crowns and roots, and also by the feeding of insects, such as white grubs, wireworms, and cutworms. Gall infections can also be spread within a planting in the pruning operations.

By fertilizing generously and practicing good culture, raspberry plantings can often be made to yield productively for a few years even though gall infections are prevalent.

If a few plants in an established planting show gall infection, digging and destroying such plants curtails the spread of galls. Since this procedure is impractical if infections are numerous, it might be advisable to destroy the planting and start a new one in a different location and with healthy plants.

COMMON NON-INFECTIOUS TROUBLES

Abnormal conditions in raspberry plants caused by adverse weather or soil conditions are common. Their symptoms are often mistaken for those of the contagious virus or fungous troubles, and growers become unduly alarmed or are lead to destroy individual plants or even entire fields needlessly.

Winter injury

Three general types of winter injury in raspberry canes may be distinguished: (1) Canes of some varieties have an inherent lack of hardiness to cold temperature. Red raspberry varieties, particularly, differ in their ability to withstand low winter temperatures. Viking and Adams 87, bred in Ontario, Canada, and Latham and Chief, bred in Minnesota, may be rated as hardy in their resistance to severe cold. June, Ontario, and Newburgh are apparently less cold resistant but are seldom affected by the minimum temperatures

in this State. Cuthbert, Cayuga, and Lloyd George are relatively tender varieties, but in the lake regions of New York even these come through most winters without injury. With black and purple varieties, less variation in winter hardiness has been observed.

Even the hardiest raspberry varieties may show winter injury of the other two types, namely, (1) cane killing at the first freezes, resulting from immaturity of wood in the fall; and (2) bud killing, resulting from breaking of dormancy during late winter or very early spring before cold weather is finally ended. The frequency with which injuries of both types occur increases the further south the latitude, where fall growth is prolonged and where winter weather is more fluctuating.

The fall type of injury varies from the more or less normal killing of the tips of the canes to the killing of the whole canes. Immature canes are particularly subject to injury near their bases. Many times, only zones of wood in the canes die and weak fruiting laterals may be produced that succumb in the hot weather for lack of moisture conduction in the cane. Often this type of injury is not completely expressed in the first growth in the spring. Many partially injured canes collapse in the summer just about fruiting time in a manner that leads growers to think that a fungus "blight" is present. Estimation of general winter damage can be most accurately made by examining the condition of the wood in the canes. The wood should exhibit a healthy, green color if there has been no winter injury.

The spring type of injury is due to unseasonably warm weather in late winter which breaks the dormancy in the buds and starts internal growth processes, although the buds may show no swelling or greening. This type of injury is more prevalent after mild than after cold winters. It is more frequent in the Hudson Valley than in the central and western parts of the State, where the lakes tend to equalize changes of temperature. Growers should give preference to sites with northern exposures as they warm up slowly and are less subject to wide fluctuations of temperature in the spring.

Injury to crowns and roots of raspberries by winter temperature alone is most rare in New York. When crown and root injury do occur through the winter season, poor drainage is usually the responsible factor.

Control

While weather vagaries play a part in the fall type of injury, this can be prevented to quite an extent by the grower. Proper

maturity of the cane wood should be encouraged by adopting cultural practices that encourage rapid and steady growth of berry canes during the spring and the summer, yet prevent too much second growth in the autumn. Cultivation should be discontinued by August 1, and a cover crop should then be sown to compete with the bushes for available soil moisture and fertility. Excessive fertilization, especially nitrate, at any time during the active growing season should be avoided. Diseases and insects that tend to defoliate the canes during the summer should be controlled. Pinching back the new canes to induce branching, so important a practice in black and purple raspberry culture, should not be done in red raspberries as it often results in immaturity of the canes and severe winter injury.

Some growers regularly plow a furrow of soil up to each side of the raspberry row in late fall to protect the crowns and base of the canes. This practice is of questionable value when one considers the possible damage to roots and crowns that might come from plowing too deep or too close. A shallow furrow thrown up by a grape hoe instead of a breaking plow is best.

Plantings have been observed where cane killing was complete in the abnormal winter of 1933-34, yet these fields produced a normal, or even better stand of new canes in 1934, with a heavy crop in 1935. Consequently, unless a site faulty in air or water drainage has been the cause for the winter damage and a repetition may be expected, a winter-injured raspberry planting should not be removed, for it will recover.

Poor drainage injury

Raspberry roots and crowns seem unusually sensitive to water relations in the soil. Complete submergence in water for a 24-hour period or longer invariably kills raspberry roots by suffocation.

In the season of their setting, young raspberry plants may make a very good growth in a poorly drained site. Typical effects, however, will invariably show up during the second season. An excessive fall water supply may cause delayed maturity of the cane wood and the canes next spring will show various degrees of weakness or death from the winter temperatures. Also, the natural rise of the water table near the soil surface during winter and spring will suffocate large portions of the root system and will weaken the crowns. Spur growth on the fruiting canes cannot be supported by the injured root and crown system and will turn yellow, wilt, and die preceding harvest. The new canes may also exhibit some wilt symp-

toms with drooping, yellowish leaves, and even purple striping. Quite frequently, especially toward fall after a new root system has developed in a dry season, growth of new canes may be normal. Such growth will be ineffective as the root system will again be drowned out in the winter and early spring and the canes will collapse in their fruiting season.

Control

Too heavy soils or those with "hardpan" should not be planted to raspberries, regardless of how fertile they may be. Sites where water collects and stands in depressions or pockets, or where springs keep soil saturated are not suitable. No site should be planted to raspberries where water will stand for a whole day. Tiling will help correct poor drainage conditions, but, in raspberry culture, it is at best a poor substitute for naturally good soil-water relations.

Wind breakage

Cane breakage caused by winds is a common condition in raspberries in New York, since high winds frequently prevail in all of the major berry-growing sections. It is most frequent on the new shoots of black and purple raspberries and with the fruiting canes of red raspberries. The cause of such injury would seem to be most obvious but oftentimes is not.

The weakest point in the raspberry plant structurally is the attachment of the canes to the crown. Whipping of the canes by wind or striking them with the cultivator often partially disrupts this union. The breakage is underground and goes unnoticed. Injured canes may wilt completely and die in a few days or they may live for several days or even weeks, displaying a variety of baffling symptoms. In injury to new shoots, the tips may die back, a broad blue stripe may creep up the stem from the base, the leaves may gradually turn yellow and drop, while weak, new growth from the secondary buds on the cane may give the plant a peculiar bunchy appearance. Such symptoms of disorder are easily mistaken for mosaic, wilt, winter injury, or injury by root-feeding insects. Injured fruiting canes gradually wilt and the berries dry up. Wind damage of this sort, even when it affects only a small proportion of the canes in a planting, may appear most alarming.

The cause of the trouble may be detected by taking hold of the injured cane near the tip and moving it back and forth. The looseness of the cane at the crown will be evident, and a gentle pull will usually break it away entirely. Upon examination, the basal end will

show bark callus and brown, dry wood and pith over the major portion of its surface where the partial break occurred some days previously. The callus formation never succeeds in repairing the injury, and there is not enough of the unbroken part of the cane to maintain a normal condition.

Control

To prevent such mechanical injury, sites for raspberries should be chosen that have some measure of protection from strong winds. In black and purple raspberries, low summer pinching of the new tips eliminates the high-bush, top-heavy sort of canes that are most subject to wind-whipping. A low ridge of soil maintained over the crown gives some support. Posts or trellises to support the canes may be necessary in some sections but are recommended only as a last resort. If the old canes that have fruited are left in place through the ensuing fall and winter, they will support the new shoots to some extent. In most cases, though, the other disadvantages of such a practice outweigh this consideration. Of course, striking the canes with cultivating implements is easily avoidable and is inexcusable.

INSECT PESTS AND THEIR CONTROL

Raspberry growers frequently sustain serious crop losses resulting from injuries by insect pests or related forms. This is equally true whether berries are grown for the canning industry, the fresh fruit market, the nursery trade, or for home use.

In New York State the importance of insects that attack raspberries appears to vary with the type of season and with the locality, though in general cane borers and the raspberry fruitworm have been more injurious than any other pests during the past five years.

INSECTS ATTACKING FRUIT AND LEAVES

The eastern raspberry fruitworm

The eastern raspberry fruitworm (*Byturus rubi* Barber) is a small, somewhat hairy, light brown beetle, $\frac{1}{8}$ inch in length (figure 10,A). It attacks purple and red raspberries, especially early varieties of red raspberries. Usually its presence is first detected at picking time when it is in the larval or "worm" stage lying between the berry and receptacle or inside the berry (figure 10,C). The full-grown larva is about $\frac{1}{8}$ inch in length, yellowish white in color, and is lightly covered with transverse rows of stiff hairs.

The adults eat holes in the new leaves (figure 10,E), sometimes seriously impairing the function of leaves. They attack the young blossom clusters and may sever one or more of the pedicles supporting the blossom buds. If the infestation is heavy, crop loss from this activity may be considerable. The adults may seriously injure the fully developed blossom buds by feeding on the floral parts (figure 10,D). The larva in burrowing through the receptacle (figure 10,B) and in feeding on the carpels of the berry destroys vital plant tissue,

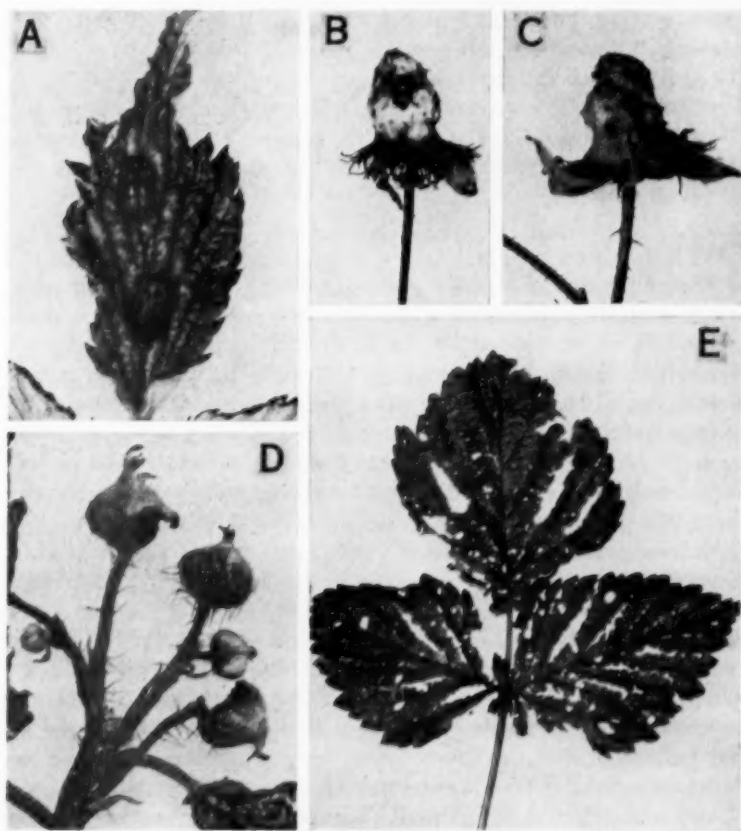


FIGURE 10. THE EASTERN RASPBERRY FRUITWORM, *Byturus rubi* BARBER

A, adults on leaf $\times 1.5$; B, larva on receptacle of berry $\times 1.5$; C, receptacle showing injury resulting from larval feeding; D, cluster of blossom buds injured by late feeding of adults; E, foliage injured by adult feeding.

and, commonly, decay of the structures follows. The affected fruit may drop before harvest time or may be unfit for sale because of injury or the presence of the larvae.

The adults emerge from the soil in April or May, usually when the new leaves are beginning to unfold. They feed wholly or partially concealed, first along the midrib of the unfolding leaf, later among the structures of the young blossom cluster, and finally on the floral parts inside the expanded blossom bud which the insect enters by boring through the sepals and petals. The female deposits her elongate, whitish eggs on or near the blossom clusters or on the green berries. The larva makes a tortuous burrow through the receptacle, terminating between this structure and the inner wall of the berry. When full grown, the larva drops to the ground where it burrows under the surface of the soil and changes to the pupal stage in which condition it passes the winter. The following spring the adult emerges from the pupal cell in the soil and repeats the life cycle.

Control

The cultivation of infested plantings during late summer or early fall to disturb or crush the pupal cells in the soil is one procedure commonly recommended for the control of the fruitworm. Stirring the soil shallowly but thoroughly and close to the plants at this season should kill many pupae thus greatly reducing the number of beetles which normally would appear the following spring. Caution must be exercised in these cultural practices, which should be followed only where conditions warrant them, since they tend to induce late growth of the plants and consequent winter injury.

In some sections and on some varieties insecticidal treatments are necessary to protect the new, young foliage from feeding injury and to prevent larval infestation of the berries. Either sprays or dusts may be used, though sprays are effective usually over a longer period. Any of three spray materials, rotenone, DDT, or lead arsenate, may be used to control the insect, but rotenone and DDT are superior to lead arsenate. The amounts of materials to be used in 100 gallons of each of the mixtures are as follows: (1) rotenone spray, powdered derris, or cubé root containing from 4 to 5 per cent of rotenone (from 3 to 5 pounds) with $\frac{1}{2}$ pound of powdered skim-milk, soybean flour, or some other neutral spreader; (2) DDT spray, 1 pound of actual DDT; (3) lead arsenate spray, lead arsenate 4 pounds, also with spreader as above. One pound of hydrated

spray lime for each pound of lead arsenate should be added to reduce the danger of arsenical injury. A 1 per cent rotenone dust or a 5 per cent DDT dust is also effective against the insect.

Where there is an increase in mite population through previous use of DDT, malathion 25 per cent wettable powder, from 1.5 to 2 pounds in 100 gallons, is a fairly effective alternative.

Regardless of the insecticide selected, two treatments should be made. All mixtures (either sprays or dusts), except lead arsenate should be applied when the first blossom buds appear and should be repeated just before the blossom buds open. The first lead-arsenate application should be made as the blossom buds are separating in the cluster and the second just before the buds begin to open. Special effort should be made to cover all leaf surfaces and to penetrate the blossom clusters with the spray or dust materials.

Two-spotted spider mite

During recent years the two-spotted spider mite (*Tetranychus bimaculatus* Harvey) has become a serious pest of raspberries generally in this State. It is usually most prevalent during hot, dry seasons which occasionally so favor its rapid multiplication as to make control extremely difficult.

These mites vary in color from pale greenish yellow to dark crimson red, usually with two dark spots on the side of the body. The mites are so small as to be barely visible to the unaided eye. The eggs are laid in large numbers on the undersides of the leaves and both the young and adult mites feed principally on the lower surfaces of the leaves. Injury is first noticed as a fine gray stippling on the upper surface of the leaves. Later these leaves may turn yellowish brown, dry, and fall off. Old, matured, less succulent leaves appear to be preferred by the mites. Fruit-spur foliage is fed upon first, the mites then migrating to the new cane foliage as the season advances but not until the chlorophyll is largely depleted in the leaves of the fruiting canes.

Severe foliage injury of the fruiting spurs markedly reduces the yield and quality of the fruit during the current season; also the feeding of the mites on the new cane foliage stunts cane growth for next year's fruit production and, by premature defoliation, predisposes canes to winter injury. During certain seasons the mites become so abundant as to swarm on the berries at harvest, resembling brown dust, thus decreasing the market value of the fruit.

Control

Extensive observations have shown that mite injury is less serious on the more vigorous plants. Rank, succulent growth appears less desirable as a food source for the mites; likewise it tends to minimize the effects of mite feeding. Consequently, cultural practices that promote and sustain rapid growth, namely, maintaining the humus content of the soil through use of manure or cover crops, early spring fertilization with nitrogenous fertilizers, and mosaic control all appear to aid greatly in reducing losses that otherwise result from red-spider infestations.

Experiments in western New York have shown that the use of 1 gallon of summer or white oil emulsion in 100 gallons of water is apparently safe to the plants and affords excellent control of the mites. This treatment has proved effective on both the mites and their eggs; even where only one thorough application is given, the mite population usually remains at a low level throughout the remainder of the summer during normal seasons. This spray can be applied any time during the growing season whenever the mite population becomes threatening or destructive.

A spray of TEPP (tetraethyl pyrophosphate), $\frac{1}{4}$ pint of 40 per cent or $\frac{1}{2}$ pint of the 20 per cent material, when the mite population appears to be increasing and a second application from 7 to 10 days later are effective against the pest; also against aphids. Since TEPP is not an ovicide, the second application is usually necessary to reach those mites in the egg stage at the time of the first spray. When diluted with water and ready for use as a spray, TEPP loses its toxicity rapidly so its immediate use after mixing is most important.

Malathion (from 1.5 to 2 pounds of the wettable powder in 100 gallons of water) is another phosphorus material suggested for use against mites. Both materials can be obtained in dust form. These insecticides should never be applied during bloom.

In plantings where the mites have been a serious pest for several years, an oil spray each year about the middle of June, or from two to three weeks before harvest, is advisable. If the first spray is properly applied, second and third applications may be made at intervals of five days to a week but will probably be unnecessary, except in very heavy infestations. Repeated applications of oil sprays have usually caused some scorching of the leaves in western New York and for that reason are not recommended except where outbreaks are unusual. In spraying it is essential to maintain high

pressure and direct the mixture upward so as to wet the mites on the under surfaces of the leaves.

All insecticides should be handled with care, especially those containing phosphorus. TEPP in concentrated form is highly toxic to warm-blooded animals. If spilled on the skin, the area should be washed well with soap and water. Avoid inhaling the fumes. From the standpoint of the operator, malathion is by far the safer material to use.

Raspberry sawfly

Under some conditions the raspberry sawfly (*Blennocampa rubi* Harris) in its larval stage may become a serious pest of red raspberries and, to a lesser degree, of blackberries and dewberries. The adult of the raspberry sawfly is a small, black, thick-bodied insect about $\frac{1}{4}$ inch in length. It appears about the time the leaves begin to unfold early in May. The female, which may be recognized by the yellowish white band that extends across the abdomen, deposits her eggs singly between the upper and lower epidermis of the leaves. The eggs hatch into spiny, many-legged, pale green worms which usually feed on the outer edges of the leaves, but as they become older they chew out irregular holes and in heavy infestations all of the leaf surface, with the exception of the larger veins, is devoured. Occasionally they may feed also upon the new bark, the blossom buds, or the young fruit. When full-grown they are $\frac{1}{2}$ inch long and are similar to the leaves in color.

Control

The larvae of this insect can be readily controlled by the use of 3 pounds of lead arsenate and 3 pounds of hydrated lime in 100 gallons of water. This procedure applies particularly when the infestations appear early in the season. For infestations that develop after the fruit is set, pyrethrum or rotenone sprays may have to be used.

Tarnished plant bug

The tarnished plant bug (*Lygus pratensis oblineatus* Say) is commonly found on many kinds of plants throughout the growing season. The adult is about $\frac{3}{16}$ inch long and variegated tan or brownish in color. The younger nymphs are green; but after the second molt, dusky markings appear on the thorax and wing pads. In the older nymphs, reddish brown, yellow, and dark green colorations predominate. Because of their alertness and agility, they are

seldom seen by the casual observer. The adults are good fliers and most agile, disappearing at the slightest disturbance.

The insects are general feeders, moving from one plant to another, often appearing to follow the succession of certain maturing fruit crops. They are sucking insects and may attack leaves, buds, blossoms, or fruit, and extensive commercial loss of certain small fruits has been observed as the result of their activity. They injure both the young, developing berries and the mature fruit.

Plant bugs overwinter in the adult stage beneath stones, leaves, or other protective cover, emerging in early spring when they feed on the new, tender foliage and buds. Oviposition takes place in various kinds of plants. Eggs may be observed later in the season in the sepals of blackberry buds and in other plant structures. The eggs are white, somewhat banana-shaped, and usually forced into plant tissue for nearly their entire length. In New York there are about four generations in one season. The tremendous build-up in population toward midsummer, therefore, poses a threat to raspberries and other later-maturing crops.

Control

While only preliminary tests have so far been made on the control of the insect on raspberries, the favorable results obtained from experiments on strawberries and blackberries indicate that spraying the foliage with DDT, 2 pounds of 50 per cent wettable powder in 100 gallons of water, will give considerable protection from the pest.

Where mites have been a problem or where the mite population has increased following use of DDT, malathion, 25 per cent wettable powder at 2 pounds in 100 gallons, may be used.

Sprays should be applied before bloom only, otherwise pollinating bees may be killed and dangerous residues left on the fruit. Since the plant bug feeds commonly on grasses and weeds, it is advisable to cover all vegetation between the rows as well as that adjoining the planting. A 5 per cent DDT dust is the second best choice for use as a control if spraying is not possible.

INSECTS ATTACKING CANES AND ROOTS

Buprestid cane borers

Two species of flat-headed borers (*Agrilus ruficollis* Fab. and *A. rubicola* Abeille) burrow through the canes of brambles. Raspberries, blackberries, dewberries, and roses are the plants most com-

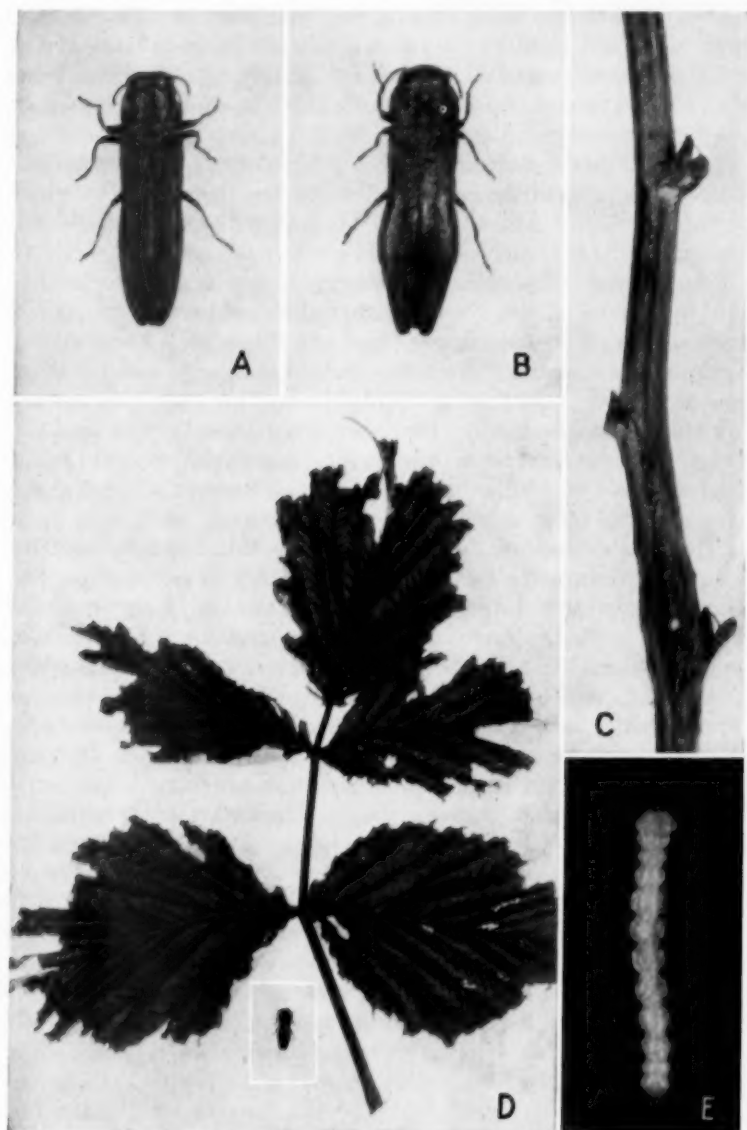


FIGURE 11. THE BUPRESTID CANE BORERS, *Agrilus* spp.

A, adult of *A. ruficollis* X5; B, adult of *A. rubicola* X5; C, infested cane showing swelling and attached shell of egg; D, feeding injury resulting from adult of *A. rubicola*; E, larva of *A. ruficollis* X2.5.

monly attacked by one or the other of these pests. *A. ruficollis* (figure 11,A) is known as the *red-necked cane borer* because of the reddish colored thorax which contrasts sharply with the black head and wing-covers. *A. rubicola* (figure 11,B) is somewhat similar in appearance except for the color which is an iridescent bronze or copper. On this account it has been referred to as the *bronze cane borer*. Specimens of the red-necked borer may measure as much as $\frac{1}{4}$ inch in length, while those of the bronze borer, especially the males, may be very much smaller.

The presence of either of these borers in a cane is indicated usually by a more or less symmetrical swelling which may be from $\frac{1}{4}$ to 3 inches in length (figure 11,C). Swellings may occur at any point on the cane from 1 inch to 4 feet above the ground, but those nearer the base signify greater probable damage. Many weak-caned varieties of raspberries infested with these borers wither and die before they can mature a crop. In most plants the affected cane is broken off or severed at the region of the swelling where the encircling larval burrows have weakened it.

The life histories of the two insects are so much alike that for all practical purposes they may be considered as one species. The beetles are present in the field from about the last of May until the first of August. On sunny days it is not uncommon to find them on the foliage where they begin feeding usually along the leaf edges (figure 11,D). The female deposits her whitish, scale-like eggs singly on the bark of the new growth and the larva (figure 11,E) on hatching starts a long, winding tunnel which consists of several turns about the cane in the sapwood, then one or more deeper series of turns through the hardwood finally terminating in the pith. The first tunnelings are in the form of a close spiral, and in this region a swelling usually develops. Beyond the swelling the spiral gradually lengthens until the burrow becomes a comparatively straight path through the pith. The general direction of the tunnel is toward the tip of the cane, but it occasionally may extend in the opposite direction. The larva is usually full-grown by fall and remains in its burrow until the following spring when it pupates and shortly emerges as an adult.

Control

Preventive measures while helpful, seldom give perfect control of these pests. They include the removal and burning of infested canes during the dormant season and the destruction of uncared for

berries, wild roses, and the like in which the beetles may breed. Parasites and diseases are an aid in suppressing the insects but cannot be relied upon for control. Insecticidal treatments offer the greatest promise. Two types of spray mixtures are available. The materials and the amounts to use for 100 gallons of spray are: (1) lead arsenate 4 pounds, and $\frac{1}{2}$ pound of soybean flour (Soy spray A), B1956 or other material to spread and stick the spray; (2) powdered derris or cubé containing from 4 to 5 per cent of rotenone 5 pounds with spreader and sticker as for the above mixture; and (3) where mites are not a problem, wettable 50 per cent DDT powder applied at the rate of 2 pounds.

Hydrated lime added to the lead arsenate spray mixture, 1 pound for each pound of arsenical used, will increase its spreading properties and give some protection against arsenical foliage injury.

If only one treatment is planned, it should be made just before the plants come into bloom. If in a severe infestation a late treatment is desired, a rotenone spray should be applied when the last petals are falling. If there is a preference for dusting, a 25 per cent lead lime dust may be substituted for the lead arsenate spray. A safe practice is to follow this application with a 1 per cent rotenone dust at the time recommended for the second spray treatment. Since objectionable residues may be left on the fruit at picking time and also because so many insecticides are toxic to bees and, under certain conditions, injurious to foliage, they should never be applied after the blossoms have opened. If a late treatment is made, picking should be delayed four or five days to allow for the breakdown and weathering of the rotenone residue. Because of the time limitations for control treatments, the preblossom applications should be so thoroughly made that all the foliage of each plant is well covered with the insecticide.

Raspberry cane borer

The raspberry cane borer (*Oberea bimaculata* Oliv.) is becoming a serious pest in some plantings. It is a rather slender beetle (figure 12,A), about $\frac{1}{2}$ inch long, and black in color except for the thorax which is bright orange with two or three black spots. The conspicuous long, black antennae are characteristic of the round-headed borers to which group this insect belongs. The beetles appear in raspberry plantings in early June and may be present until late in August. They feed mostly on the tender green epidermis of the cane tips, leaving brownish patches or scars (figure 12,B).

Ordinarily the first observed injury due to this insect is the wilting of the tips of the new canes and laterals resulting from encircling rows of punctures made by the female previous to ovipositing. There are usually two of these puncture rings about $\frac{1}{2}$ inch apart and 6 inches or so from the tip of the cane or lateral (figure 12,C). They restrict the flow of sap which commonly results in the blackening and abscission of the tip within a few days (figure 12,D). The most severe injury is to the cane which may die before fall or before the fruit matures the next season. The pith is destroyed and the cane wall is riddled with holes made by the larva in its descent (figure 12,E). After completing the puncture girdles with her mandibles, the female deposits an egg in the space between them (figure 12,C). This is inserted through a puncture in the epidermis and deep into the pith of the cane. The larva (figure 12,F) on hatching burrows toward the base of the cane which it usually reaches before fall. The following winter and summer is spent in the root and canes and the next spring pupation takes place, as a rule, in an old stub from which the adult emerges a short while later.

Control

Preventive measures against this pest are an aid in its suppression. These consist of (1) cutting-off the wilted tips several inches below the girdled portion just as soon as found, (2) removing and destroying all infested canes whenever seen, (3) crushing the old stubs in early spring before the adults emerge, and (4) the eradication of wild brambles in which the insect may breed.

The recommended insecticidal control is a spray applied directly before the blossoms have opened. The materials and amounts to use in 100 gallons of spray are as follows: (1) ground derris root, 4 to 5 per cent rotenone, (5 pounds) and a spreader as suggested above for the control of flat headed borers; (2) lead arsenate 5 pounds, hydrated lime 5 pounds, and spreader. In a heavy infestation, the rotenone treatment should be repeated when the last petals are falling. Because of objectionable residue, no fruit should be harvested for several days following this application. Mixtures 2 and 3 should never be applied after the blossoms have opened since they may leave toxic residues on both the blossoms and the fruit.

If dusting is preferred to spraying, a 1 per cent rotenone dust may be substituted for the first spray and the treatment repeated as the last petals are falling. To be effective, all materials should be thor-

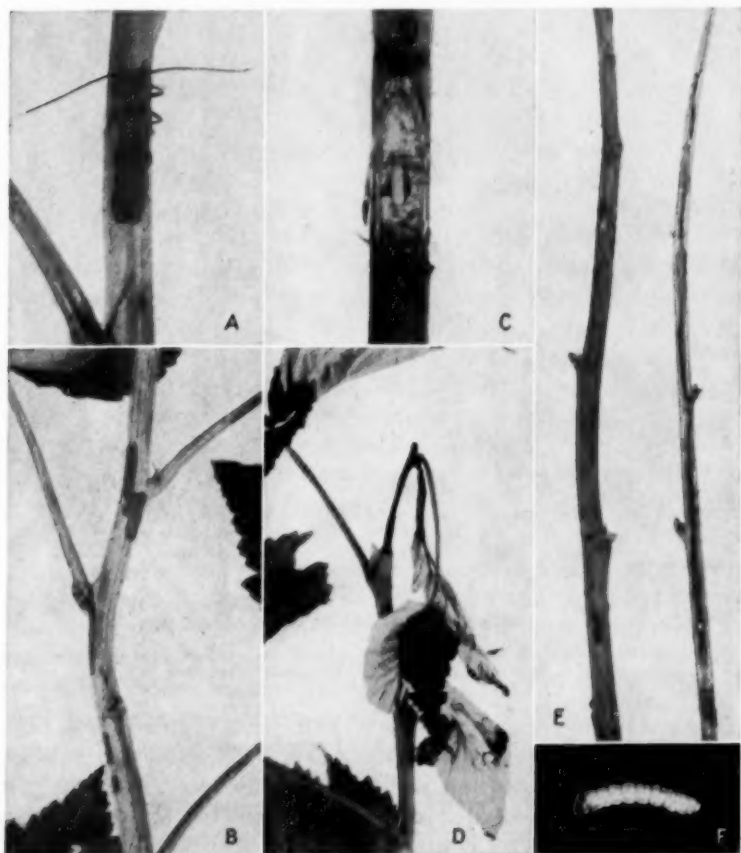


FIGURE 12. THE RASPBERRY CANE BORER, *Oberea bimaculata* OLIV.

A, adult beetle X2; B, injury on cane resulting from feeding of beetle; C, dissected cane, showing egg between two puncture rings; D, injured tip desiccated and blackened; E, cane at left shows holes made by the larva in its descent, while cane at right is dissected and shows larval burrow; F, larva X1.3.

oughly applied, special attention being given to the tip ends of the new growth and to the laterals of the fruiting canes.

Tree cricket

Tree-cricket (*Oecanthus nigricornis quadripunctatus* Beut.) injury results from the egg punctures made by the females in the canes. These punctures are noticed as small holes, very close together,



FIGURE 13. TREE CRICKETS INFESTING RASPBERRIES

A, adults on foliage of cane having egg-puncture scar; B, cane showing egg-puncture scars; C, injured cane dissected to show cricket eggs.

arranged in rows running lengthwise of the cane (figure 13,B and C). They vary from a few to 50 or more in a row. Usually the rows are from 2 to 3 inches long and, while they may appear on most any part of the cane, they are frequently within a foot or two of the tip. These punctures weaken the canes and they may split or break under strain. The injury on the lower portion of the plant may weaken the cane enough to prevent normal development of the fruit the following season.

The tree cricket (figure 13,A) is a rather delicate, greenish white, slender-bodied insect with long dark colored antennae which are usually much longer than the body. Either the nymphs or adults may be found on raspberries or other plants during most of the summer. Generally speaking, tree crickets are not injurious enough in raspberry plantings, at least in western New York, to necessitate special control measures. This applies particularly where new canes receive the necessary amount of pruning back each season and the practice of burning the wood that is cut out is followed. It is, however, always advisable to remove and destroy infested canes whenever seen.

Raspberry cane maggot

The adult of this insect (*Pegomya rubivora* Coq.) is a two-winged fly which closely resembles the house fly but is slightly smaller in size. While generally present, this insect seldom becomes an economic pest to raspberry growers, although a certain amount of injury probably occurs each season. The injury is somewhat similar to that caused by the raspberry cane borer in that the new tips wilt, and die. The maggot burrows into the pith, then tunnels its way down the cane, later works toward the bark and gradually girdles the shoot from the inside causing the part above to droop and die.

Control

The simplest and best method of control is to cut off the infested shoot several inches below the girdle and burn these canes. The wilted new shoots are easily seen in the field and usually begin to appear as early as May. No satisfactory spray or dust program is available.

Raspberry root borer

The raspberry root borer (*Bembecia marginata* Harris) is a beautiful, thick-bodied, clear-winged moth having a wing spread of 1 to 1½ inches and with four bright yellow bands across the abdomen. At present it appears to be gaining prominence as a pest of raspberries. The first indication of injury by this moth is the wilting and dying of the foliage of the affected cane. Several canes of a bush may be weakened by the activity of a single larva in the crown, and the entire bush may be killed. The insects appear in early August and are present during most of September. The females may be seen during the day resting on the leaves where they deposit their reddish brown eggs on the under surface close to the edge. On hatching the young larva makes its way toward the base of the cane where it may either excavate a cavity in which to hibernate or find a suitable crevice in the bark for this purpose. In the spring it enters the crown and also burrows into the roots, but usually manages to tunnel into a new cane and then girdles it before returning to the roots again. The second winter is spent in the roots and later the following summer an old stub is usually entered. Here pupation is completed sometime in August after which the adult emerges.

Control

There is no direct control for this pest and one must therefore depend on preventive measures. These include the destruction of

dying canes and those showing evidence of borings. If there are indications of a burrow in the crown after the cane has been broken away, it should be probed with a piece of wire to kill any larvae present. Breaking over and crushing the old stubs in May or June is probably the most effective practice since they are almost sure to contain larvae or pupae. The eradication of wild brambles is always advisable because they may harbor the pest.

White grubs

Several species of white grubs, the larvae of May beetles or June bugs, may feed on the roots of raspberry plants. These white grubs when mature are large, thick-bodied, strongly curved, white larvae approximately 1 inch in length. They frequently become quite numerous on land that has been in grass sod for several years or in locations where other food plants which they frequent have been grown.

These grubs require from one to several seasons to complete their development in the soil, depending upon the species, and during this time are capable of doing considerable damage to the roots and underground portions of the plants. When mature, they construct earthen cells, transform to pupae, and the adults emerge the following spring.

Control

The control of white grubs through the use of insecticides has always been a difficult problem and thus far no very satisfactory measure has been devised. Certain cultural practices, however, have proved of some value. For example, it is considered bad practice to plant certain crops, such as berries, on land known to be heavily infested with grubs. Furthermore, newly broken sod land should be cropped at least one year to peas, beans, or some other crop less subject to injury than raspberries; otherwise, through lack of food the grubs may attack the raspberries with disastrous results.

The common June bug has a life cycle of three years; the adults, or beetles, appear every third year. The flight years therefore can be predicted with certainty. Since the greatest damage is in the year after the beetles were numerous, growers in infested areas that year can expect maximum damage from the larvae the following season. Areas of heavy beetle concentration may be roughly defined as (1) the Champlain Valley, (2) two southern tier counties, (3) a small area in central New York, and (4) parts of some Lake Ontario counties.

HARVESTING

Raspberries, because of their perishable nature, require very careful handling. The most common cause of decay is mechanical injury resulting from carelessness in harvesting. No amount of after care can overcome the effects of rough and careless handling in the field. Usually, the field should be picked every other day, or every day if the weather is very hot. During a cool spell it may be enough to pick every three days. Always, one should pick often enough to prevent any considerable number of over-ripe berries. Soft varieties must be picked more frequently than firm varieties. Proper picking is a matter of thorough organization, proper instruction of pickers in methods of handling berries, constant supervision, and careful inspection of work. The grower should insist on good workmanship.

Pickers should be assigned the same rows throughout the season, as this will enable the worker to place the responsibility for poor workmanship. Instruct the pickers to pick only one berry at a time and to place it in the basket before picking another. Pick with three fingers instead of two to distribute the pressure on the berry more evenly. Do not attempt to sort or pick berries out of partly filled baskets. Avoid putting in any berries that should later be removed. Discard or put in separate receptacle all over-ripe berries. Growers intending to ship their berries should train the pickers to put the fully ripe berries in one basket and the firm berries suitable for shipping in another. The fully ripe berries may be marketed locally or may go to the canning factory. Do not pick berries until they are mature and will slip off the core without crumbling. Set the carrier in the shade of the row as the berries go down very quickly in the sun. As soon as possible remove the field baskets to a cool shady spot under trees or to a cool cellar. Never pick wet berries as they will mold quickly.

Varieties vary considerably in their picking qualities. A soft variety, such as June, requires the most careful handling the grower can give it. Latham, which tends to crumble, requires care to prevent tearing the berry apart. Varieties which turn dark quickly must be picked early and while still bright red, or they will be unpopular on markets that like bright varieties. Newburgh must be fully ripe to slip off the core rapidly, but because of its firmness and good keeping qualities will not suffer if not picked as soon as Cuthbert or June.

Varieties with prickly canes and the fruit more or less hidden in the foliage are disliked by the pickers who tend to miss many berries on such varieties. June, Ontario, Latham, and Viking, with their

smooth canes and fruit borne out in the open, are much liked by pickers. Newburgh has prickles but bears its fruit in the open so picking is not difficult. A narrow hedge row is easier to pick than a wide hedge row, and supported canes easier than unsupported.

Pint baskets are to be preferred, especially for red raspberries. Consumers prefer pints because of the higher price of quarts, and growers get more for the crop in smaller packages. There is less crushing of berries in pints and they are almost essential for soft varieties. Shallow baskets are preferable as they prevent crushing and offer a larger surface for display. Only clean new baskets should be used. Crates holding 16, 24, and 32 quarts are used, the 24-quart size being most popular. Crates holding 24 pints are popular. The lighter crates have the advantage of receiving better handling. Loaded crates should not be dropped, jolted or tipped on end.

A small packing shed is desirable for larger plantings that are not located near the main farm buildings. This will serve as basket storage, provide shade for harvested fruit, and shelter for pickers in case of rain.

Six or eight pickers per acre are usually needed. Adults are preferable, but children over 12 years of age may do good work if properly supervised. A succession of berries from early strawberries through raspberries and blackberries will enable the grower to build up a smooth-working organization.

YIELDS

Prospective growers often raise the question as to the yields that may be expected from an acre of raspberries. This question cannot be answered definitely since yields are greatly influenced by rainfall, winter injury, soil fertility, conservation of moisture, cultural practices, number of canes per acre, pruning, previous season's growth, varieties, age of planting, and diseases. A fair yield of red raspberries is 2000 to 2500 quarts per acre. A high yield is 4000 quarts to the acre and this will be attained only when excellent cultural conditions prevail. Black raspberry yields should average somewhat higher if the mosaic diseases are held to low amounts. In a fertilizer experiment conducted by the Experiment Station in a field on the west side of Canandaigua Lake, yields of Cumberland black raspberries as high as 4700 quarts to the acre were obtained.

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